



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
501 West Ocean Boulevard, Suite 4200
Long Beach, California 90802-4213

June 30, 2006

In response refer to:

151422SWR2005AR00792:KM

Mr. Eric Nelson
Refuge Manager
Humboldt Bay National Wildlife Refuge Complex
U.S. Fish and Wildlife Service
P.O. Box 576
Loleta, California 95551

Ms. Jane Hicks
Chief, Regulatory Branch
San Francisco District
U.S. Army Corps of Engineers
333 Market Street
San Francisco, California 95502-3700

Dear Mr. Nelson and Ms. Hicks:

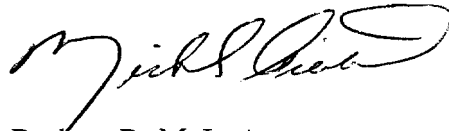
This letter transmits NOAA's National Marine Fisheries Service's (NMFS) biological opinion (Opinion) for the United States Fish and Wildlife Service's Humboldt Bay National Wildlife Refuge implementation and the U.S. Army Corps of Engineers' permitting of the Salmon Creek Anadromous Salmonid Access, Tide Water Habitat Enhancement, and Flood Control Maintenance Projects (hereafter referred to as Project), near Loleta, Humboldt County, California. The Opinion (enclosure 1) addresses the effects of the Project on the following threatened species and designated critical habitats in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*): (1) Southern Oregon/Northern California Coast (SONCC) coho salmon (*Oncorhynchus kisutch*) Evolutionarily Significant Unit (ESU), listed on June 28, 2005 (70 FR 37160); (2) California Coastal (CC) Chinook salmon (*O. tshawytscha*) ESU listed on June 28, 2005 (70 FR 37160); (3) Northern California (NC) steelhead (*O. mykiss*) Distinct Population Segment listed on January 5, 2006 (71 FR 834); (4) SONCC coho salmon critical habitat, designated on May 5, 1999 (64 FR 24049); (5) CC Chinook salmon critical habitat, designated on September 2, 2005 (70 FR 52488); and (6) NC steelhead critical habitat, designated on September 2, 2005 (70 FR 52488). In the Opinion, NMFS determined that the Project is not likely to jeopardize the continued existence of threatened SONCC coho salmon, CC Chinook salmon, or NC steelhead, and is not likely to adversely affect the designated critical habitats of SONCC coho salmon, CC Chinook salmon, or NC steelhead. This concludes ESA consultation in accordance with 50 CFR 402.14 for the proposed Project.



The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267, 16 U.S.C. 1801 *et seq.*) and its implementing regulations [50 CFR part 600.920(a)] requires that before a Federal agency may authorize, fund, or carry out any action that may adversely affect Essential Fish Habitat (EFH), that agency must consult with NMFS. NMFS evaluated the Project for potential adverse effects to EFH pursuant to section 305(b)(2) of the MSFCMA. The action area of the Project includes areas identified as EFH for various life stages of Pacific Coast salmon, Pacific Groundfish, and Coastal Pelagic species. Based on the best available information, NMFS has determined that the Project will not adversely affect EFH. Therefore, EFH consultation is not warranted.

Please contact Ms. Keytra Meyer at (707) 825-5168, or via e-mail at keytra.meyer@noaa.gov, if you have any questions concerning this consultation.

Sincerely,



for Rodney R. McInnis
Regional Administrator

Enclosure

cc: Mike Shirley, U.S. Army Corps of Engineers, Eureka
Aldaron Laird, Arcata

Enclosure

BIOLOGICAL OPINION

ACTION AGENCIES: U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers

ACTIVITY: Salmon Creek Anadromous Salmonid Access, Tide Water Habitat Enhancement, and Flood Control Maintenance Projects

**CONSULTATION
CONDUCTED BY:** National Marine Fisheries Service, Southwest Region

FILE NUMBER: 151422SWR2005AR00792

DATE ISSUED: JUN 30 2006

I. BACKGROUND AND CONSULTATION HISTORY

On November 22, 2005, NOAA's National Marine Fisheries Service (NMFS) received a request from the United States Fish and Wildlife Service's (USFWS) Humboldt Bay National Wildlife Refuge (Refuge) to initiate informal consultation on the Salmon Creek Anadromous Salmonid Access, Tide Water Habitat Enhancement, and Flood Control Maintenance Projects (Project), with an accompanying Biological Assessment (BA) prepared by Aldaron Laird (Refuge's Consultant). During conversations between Ms. Keytra Meyer, NMFS, and Mr. Aldaron Laird on December 9, 2005, Mr. Laird stated that the Refuge would be rescinding its request for informal consultation and would be requesting to initiate formal consultation on the proposed Project. At Mr. Laird's request, Mr. Dan Free, NMFS, sent Mr. Laird emails on December 16, 2005, and January 4, 2006, noting 50 CFR § 402.14 requirements for initiating formal consultation, and a list of specific Project activities that may adversely affect listed salmonids and, therefore, needed to be addressed in the BA. On March 17, 2006, the Refuge, NMFS, USFWS, Mr. Laird, and Project Planners and Engineers (Mr. Mitch Farro, Mr. Michael Love, and Mr. Jeff Anderson) met to discuss the final BA (Laird 2006) for the Project. At this meeting, the Refuge submitted a request for formal consultation on the Project. This biological opinion (Opinion) addresses the effects of the Project on Southern Oregon/Northern California Coast (SONCC) coho salmon, California Coastal (CC) Chinook salmon, Northern California (NC) steelhead, and their designated critical habitats in accordance with section 7 of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. 1531 *et seq.*).

A complete administrative record for this consultation is on file at the NMFS Arcata Area Office.

II. DESCRIPTION OF THE PROPOSED ACTION

The Project includes: (1) replacement of three existing tide gates [one three-chamber tide gate (referred to hereafter as East Tide Gate) and two single barrel/chamber tide gates]; (2) construction of one new tide gate (hereafter referred to as West Tide Gate); (3) excavation of 75 cubic yards (cy) of sediment from 100 feet of channel to remove an existing knick point; (4) excavation of 250 cy of sediment from 50 feet of channel to restore two channel outlets to adjacent wetlands; and (5) placement of 72 cy of concrete on the Hookton Slough Levee and approximately 1,350 cy of sediment on the Cattail Levee. The purposes of the Project are to enhance anadromous fish passage between Salmon Creek and Humboldt Bay, increase the tidal prism to inundate a larger area and potentially enhance estuarine conditions in Salmon Creek, and to reduce flooding of private lands. For the purposes of this Opinion, the Project also includes the U.S. Army Corps of Engineers' (Corps) permitting of the above activities.

Construction is planned to occur during the low flow and the dry season between July 1 and October 31, 2006. Construction of both the West Tide Gate and the East Tide Gate replacement may require 40 days each to complete. The replacement of both single barrel/chamber tide gates will occur during a single low tide cycle. Excavation of the knick point in Salmon Creek and wetland channel outlets will occur at the end of the work season in October.

A. Action Area

All of the proposed activities will occur on Federal land (Assessor Parcels 311-18-101 and 311-19-101) in the Salmon Creek and Hookton Slough units of the Refuge. The Project is located west of Interstate Highway 101 in Humboldt County in Sections 5 and 6 of Township 3 North, Range 1 West, and Sections 31 and 32 of Township 4 North, Range 1 West, Humboldt Meridian, U.S. Geological Survey Fields Landing quadrangle. The Project is located in the California coastal zone on 197 acres of diked former tidelands.

The action area is defined as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action" (50 CFR § 402.02). For the purposes of this consultation, the action area includes Salmon Creek and the surrounding 197 acres of wetlands on the Refuge property, as well as Hookton Slough and Humboldt Bay downstream to its confluence with the Pacific Ocean.

B. Project Description

1. Access and Staging Areas

Heavy equipment and trucks will use the Refuge's roads and levees to access the tide gates and channel excavation work sites and levee areas for disposal of excess excavated materials. At the West and East Tide Gates, equipment and vehicles will utilize temporary access routes (10 feet wide) that will be built from the levee to the surface below and across the interior coffer dam during construction. After construction, the tide gates will function as bridges to facilitate

vehicular access along the levee. Access to the knick point in Salmon Creek and wetland outlet channels will be from the levee along Hookton Slough and will be limited to the dry season.

There will be three staging areas for equipment and materials that will be located at existing wide areas on the levees or at the intersection of levees, sufficient to accommodate vehicle/equipment turn-around, and storage. The levee staging areas for work at the two tide gates on Hookton Slough will be at the end of the slough near the intersection of the south boundary and slough levees. For the tide gate at the confluence of Salmon Creek (East Tide Gate), the existing levee on either side of the structure has sufficient area for staging and turn-around. For the new West Tide Gate, there is also sufficient area at the intersection of the Hookton Slough levee and the Cattail Levee, to accommodate staging, storage and vehicle turn-around. The staging area at the mouth of Salmon Creek and end of Hookton Slough will be utilized for excavation at the knick point in Salmon Creek as well as for excavation of the two wetland outlet channels. Sediment excavated from Salmon Creek and the wetland outlet channels will be temporarily placed on silt cloth to dry out before loading and transporting to the Cattail Levee.

2. Replacement of Three Tide Gates

a. South Bank of Hookton Slough

The tide gate along the south bank of Hookton Slough consists of a 5-feet by 8-feet concrete structure with a top-hinged tide gate. The existing cement structure will be retained and a new side-hinged tide gate with an auxiliary door will be installed. The replacement will not require any excavation or fill, but may require minor cement and metal work to fit the new gate to the existing concrete structure. The replacement will occur in a single day during a period of no runoff and at low tide. Therefore, the installation of flow barriers, fish barriers, or de-watering of the work area will not occur.

b. End of Hookton Slough

The tide gate at the end of Hookton Slough is a 36-inch diameter steel culvert-pipe with a flap gate that leaks. This gate will be replaced with a 48-inch corrugated culvert with a rolled sleeve fitted with a drop-in side-hinge tide gate. Approximately 50 cy of new “bedding” (material composed of washed and sorted gravel and bentonite clay) will be laid down to form a seal around the pipe. Any excess material displaced by the larger diameter pipe will be used to increase the elevation of Cattail Levee without expanding its footprint. Replacement of this tide gate involves the excavation of the levee to pull the existing culvert/tide gate, and making a temporary “cut” of 400 square feet to accommodate the larger diameter replacement culvert/tide gate and backfill. There will be no expansion of the levee footprint. The replacement will also occur in a single day during a period of no runoff and at low tide. Therefore, the installation of flow barriers, fish barriers, or de-watering of the work area will not occur.

c. East Tide Gate (Mouth of Salmon Creek)

The replacement of the existing East Tide Gate structure will improve anadromous salmonid fish access and increase the tidal prism in Salmon Creek. The concrete structure (99 cy) will have three chambers (6 feet by 8 feet), two fitted with aluminum side-hinged tide gates, and the center chamber an adjustable top-hinged aluminum tide gate. The adjustable opening (0-feet to 3-feet high) will be used to create a muted tide cycle, allowing tidal mixing and continuous fish passage between Hookton Slough and Salmon Creek estuary. The inverts of the chambers will be set at an elevation of minus 3 feet to provide a minimum of 1 foot of water depth at the lowest tide.

Replacement of the existing structure will first require saw cutting the concrete apron from this structure, which will then be demolished and removed to an existing levee along Hookton Slough, where approximately 72 cy of concrete will be used to armor the Hookton Slough levee north of the Long Pond. All protruding metal will be cut before placement as riprap. Approximately 14 cy of rock slope protection (RSP), up to 2.5 tons, will be temporarily removed, re-placed, and stacked 1:1 to blend into the slough side of the levee and existing concrete apron covering 367 square feet, and new RSP approximately 300 feet in length, comprising 28 cy will cover 753 square feet on the interior. No excavation of the Salmon Creek slough channel is required to transition to the tide gate.

Replacement of the East Tide Gate will require that the work area be isolated from tidewater in Hookton Slough and freshwater discharge from Salmon Creek. A short distance upstream from the tide gate is a “T” junction in Salmon Creek. A fish screen and flow barrier will be erected just downstream from this junction to re-direct all of Salmon Creek’s discharge through the overflow area’s channel, which drains to the proposed constructed West Tide Gate. During a receding tide, the channel will mostly drain and then a temporary fish screen will be erected across the low tide channel in Hookton Slough. Once fish screens are installed, an authorized biologist will remove any fish present by seine netting between the upper and lower screens. All fish captured will be recorded and then relocated into Hookton Slough. The fish screen in Hookton Slough will be removed as soon as the sheet piling cofferdam is installed. The fish screen upstream in Salmon Creek may remain and be re-enforced to serve as a fish barrier to ensure that fish do not become impinged or entrained in the upstream cofferdam below the junction.

A temporary sheet piling cofferdam will be installed during low tide when the mudflat area is not inundated and as much of the slough channel is drained to an elevation of 10 feet. This cofferdam will be installed from the existing levee surface without placing fill. However, the approximately 75 feet of sheet piling (filling 210 square feet of channel) is being considered a temporary fill. The cofferdam will be made from 4-feet by 4-feet by 5-feet fabric bags filled with native material (144 cy), covered with geotextile fabric, back filled with native material and covered with geotextile fabric, which will be used as a cross over road for equipment access during tide gate installation. If water infiltrates the work site after installing the cofferdams, water will be pumped to the slough channel behind the cofferdam to dewater the work area.

3. Installation of New Tide Gate (West Tide Gate)

The construction of a new West Tide Gate structure will improve anadromous salmonid fish access and increase the tidal prism in Salmon Creek. The new West Tide Gate will be identical to the East Tide Gate described previously. The concrete structure (99 cy) will have three chambers (6 feet by 8 feet), two fitted with aluminum side hinged gates, and the center chamber an adjustable top hinged aluminum gate. The adjustable opening (0-feet to 3-feet high) will be used to create a muted tide cycle, allowing tidal mixing and continuous fish passage between Hookton Slough and Salmon Creek estuary. The inverts of the chambers will be set at an elevation of minus 3 feet to provide a minimum of 1 foot of water depth at the lowest tide.

Construction of the new tide gate will involve 48 cy of permanent fill covering 1,304 square feet and 62 cy of temporary fill covering 560 square feet, as well as excavation (cut) of 919 cy of material in 1,803 square feet. Construction of the West Tide Gate structure will require removing approximately 360 cy from 650 square feet of the levee. Approximately 23 cy of RSP, up to 2.5 tons covering 623 square feet, will be temporarily removed and re-placed on the slough side of the new structure and levee, and new RSP comprising 48 cy will cover 1,304 square feet on the interior. Approximately 270 cy will be excavated from 1,195 square feet of slough channel to transition to the tide gate. A temporary cofferdam will be installed, filling 560 square feet of channel on the interior of the levee with 62 cy of material. Excavated material will be used to enhance elevations of Cattail Levee on the Refuge. No fill will be placed below mean high water (MHW) elevation.

During an ebb tide, an authorized biologist will remove any fish present by seine netting them out of the channel. Before an incoming tide, a temporary fish barrier/screen will be placed in the slough channel downstream of where the interior cofferdam will then be constructed. After the fish barrier/screen is installed, another pass with a seine net will remove any fish remaining, relocating them downstream of the fish barrier/screen.

Construction of the West Tide Gate will require that the work site be isolated from tidewater in Hookton Slough. This will be accomplished by installing a temporary sheet piling cofferdam, during low tide when the area is not inundated, to an elevation of 9 feet with a vibratory plate rather than pounding from a pile driver. Installation of this cofferdam can be achieved from the existing dike surface without placing fill. A temporary cofferdam will be installed during low tide, on the inside of the levee when the mudflat is not inundated, to isolate the work area. The cofferdam will be made from 4-feet by 4-feet by 5-feet fabric bags filled with native material and covered with geotextile fabric and will be used as a cross over road for equipment access during. If water infiltrates the work site after installing these cofferdams, water will be pumped to the slough channel behind the cofferdam to dewater the work area.

4. Excavation of Knick Point and Wetland Channel Outlets

Approximately 1,900 feet upstream from the East Tide Gate on Salmon Creek, a knick point will be excavated (see figure 1) by removing approximately 75 cy of sediment over 100 feet of channel. The channel will be restored to a trapezoidal cross section similar to dimensions

downstream (approximately 10 feet wide at the base, 15 feet wide at top of bank, and 6 feet deep). This should increase tidal influence 1,000 feet upstream as well as enhance sediment routing. Excavated sediments will be placed on Cattail Creek dike above MHW elevation. Unimproved access (excavator and truck) will be utilized to reach this site on Salmon Creek.

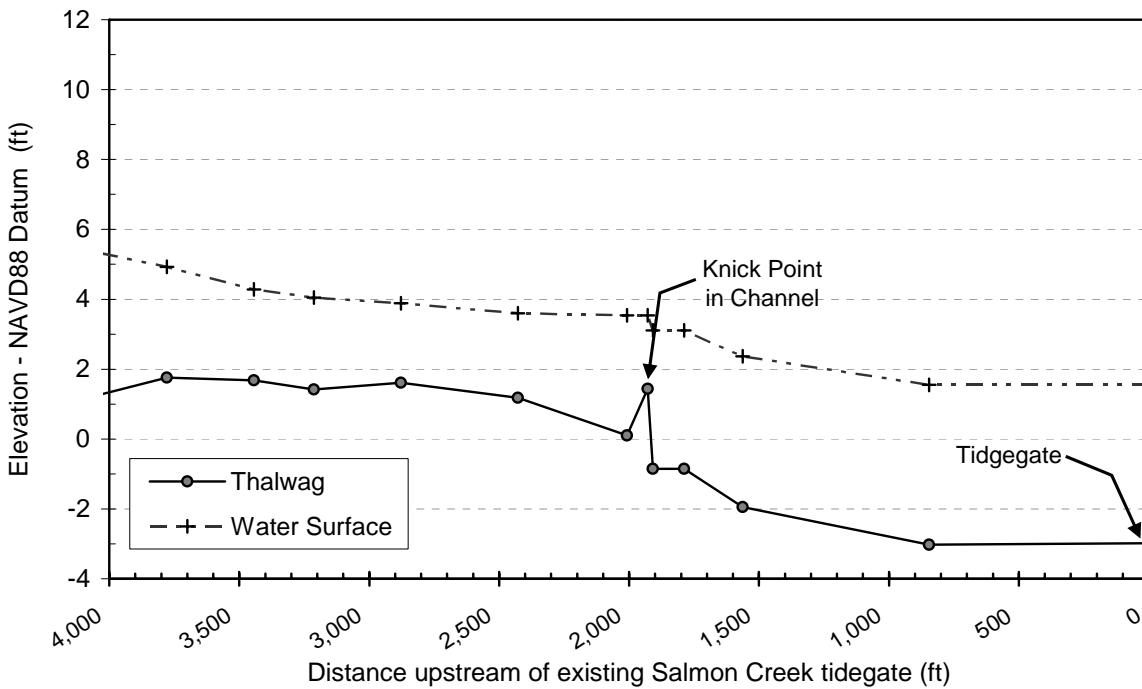


Figure 1. Salmon Creek profile [Pacific Coast Fish, Wildlife, and Wetlands Restoration Association (PCFWWRA *et al.* 2003)].

Channel maintenance is proposed to improve connectivity between two adjacent wetlands and Salmon Creek and thus, expand estuary habitat area, and reduce mosquito breeding habitat. Channel outlets from two adjacent wetlands created in the lower estuary reach of Salmon Creek have filled with sediment. Channel excavation is proposed to remove approximately 250 cubic yards of accumulated sediments from 50 feet of channel, restoring previous channel dimensions (approximately 3 feet wide at the base, 8 feet wide at top of bank, and 2.5 feet deep).

An authorized biologist will place a temporary fish barrier/screen in Salmon Creek, during an ebb tide, above the knick point work site. The biologist will remove any fish present by seine netting them down Salmon Creek and then installing a second temporary fish barrier/screen below the work site. After that, another pass with a seine net will remove any fish remaining, relocating them downstream of the fish barrier/screen. The two adjacent wetland outlet channels will be blocked off with fish screens above and below the reach of channel to be excavated, and an authorized biologist will remove any fish present with a seine net, relocating them downstream of the fish barrier/screen.

The West and East Tide Gates will be closed to prevent tidewater access to Salmon Creek during excavation of the knick point. A temporary cofferdam will be installed, between the banks of Salmon Creek upstream of the knick point, which will be made from 4-feet by 4-feet by 5-feet fabric bags filled with native material and covered with geotextile fabric. Impounded water will be pumped around the work site and returned to Salmon Creek below. Temporary cofferdams will be installed at the confluence of Salmon Creek and the adjacent wetland outlet channels to prevent tidewater intrusion to the work sites. Temporary cofferdams will also be placed in the wetland outlet channels, immediately above the area to be excavated, to prevent the wetlands from draining into the excavation areas.

5. Levee Erosion Maintenance

Hookton Slough forms a sharp bend north of Long Pond tide gate, which is eroding the right bank levee. The approximately 72 cy of concrete generated from the replacement of the East Tide Gate will be used to armor the Hookton Slough levee north of Long Pond. All protruding metal will be cut from the broken concrete before placement as riprap. Approximately 1,350 cy of sediment excavated from the levees to construct the West and East Tide Gates, as well as from excavating the knick point and two outlet channels, will be placed on top of the Cattail Levee to increase its elevation, but not expand its footprint. All levee/dike fill work will occur during low tide when the area is de-watered, or in the case of the dike, on surfaces that are not inundated.

III. STATUS OF THE SPECIES AND CRITICAL HABITAT

This section describes the legal status of the species and critical habitat, species life history and population trends and factors for the species decline at the Evolutionarily Significant Unit (ESU)/Distinct Population Segment (DPS) scale. The following listed threatened species and designated critical habitats occur in the action area and may be affected by the proposed action: SONCC coho salmon, CC Chinook salmon, NC steelhead, and their designated critical habitats. Table 1 presents a summary of the Federal Register Notice (FR) dates and citations, and geographic distributions for the species and critical habitat.

A. Critical Habitat

This Opinion analyzes the effects of the proposed action on designated critical habitat for SONCC coho salmon, CC Chinook salmon and NC steelhead. Critical habitat is defined as “the specific areas within the geographical areas occupied by the species, at the time it is listed, on which are found those physical and biological features essential to the conservation of the species and which may require special management considerations or protection, or specific areas outside the geographical area occupied by the species at the time it is listed when the Secretary determines that such areas are essential for the conservation of listed species.” The Endangered Species Act (ESA) further defines conservation as “to use all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to the ESA are no longer necessary.”

1. Summary of Designated Critical Habitat for SONCC Coho Salmon

Critical habitat for the SONCC coho salmon ESU encompasses accessible reaches of all rivers (including estuarine areas and tributaries) between the Mattole River in California, and the Elk River in Oregon, inclusive (May 5, 1999, 64 FR 24049). Excluded from SONCC coho salmon designated critical habitat are: (1) areas above specific dams identified in the FR notice; (2) areas above longstanding, naturally impassible barriers (*i.e.*, natural waterfalls in existence for at least several hundred years); and (3) tribal lands.

Table 1. The scientific name, listing status under the Endangered Species Act, *Federal Register Notice* citation, and geographic distribution of the ESUs and DPS addressed in this Opinion.

	SONCC coho salmon ESU	NC Steelhead DPS	CC Chinook Salmon ESU
Scientific Name	<i>Oncorhynchus (O.) kisutch</i>	<i>O. mykiss</i>	<i>O. tshawytscha</i>
Listing Status	Threatened	Threatened	Threatened
<i>Federal Register Notice</i>	June 28, 2005 (70 FR 37160)	ESU listed on June 7, 2000 (65 FR 36074) Relisted as a DPS on January 5, 2006 (71 FR 834)	June 28, 2005 (70 FR 37160)
Geographic Distribution	from Cape Blanco, Oregon, to Punta Gorda, California	from Redwood Creek (Humboldt County), south to the Gualala River, inclusive	from Redwood Creek (Humboldt County) south through the Russian River
Critical Habitat Designation	May 5, 1999 (64 FR 24049)	September 2, 2005 (70 FR 52488)	September 2, 2005 (70 FR 52488)

The final rule designating SONCC coho salmon critical habitat (May 5, 1999, 64 FR 24049) indicated that the essential habitat types for: (1) juvenile summer and winter rearing areas and adult spawning are often located in small headwater streams and side channels, (2) juvenile migration corridors and adult migration corridors include the small headwater streams and side channels as well as mainstem reaches and estuarine zones, and (3) growth and development to adulthood occurs primarily in near- and off-shore marine waters, although final maturation takes place in freshwater tributaries when the adults return to spawn. The essential habitat types of SONCC coho salmon designated critical habitat in the action area are: (1) juvenile and adult migration corridors (essential features of these areas include cover from predation) and (2) near-shore marine waters that support growth and development.

2. Summary of Designated Critical Habitat for NC steelhead and CC Chinook salmon

Critical habitat for NC steelhead and CC Chinook salmon includes the stream channels within the stream reaches as identified within the final rule (September 2, 2005, 70 FR 52488), and includes a lateral extent as defined by the ordinary high-water line (33 CFR 329.11). In areas for which the ordinary high water line has not been defined pursuant to 33 CFR 329.11, the lateral extent will be defined by the bankfull elevation. Bankfull elevation is the level at which water begins to leave the channel and move into the floodplain and is reached at a discharge which generally has a recurrence interval of 1 to 2 years on the annual flood series. Critical habitat in estuaries (*e.g.*, Humboldt Bay) is defined by the perimeter of the water body as displayed on standard 1:24,000 scale topographic maps or the elevation of extreme high water, whichever is greater. In the final rule, NMFS stated that “In estuarine areas we believe that extreme high water is the best descriptor of lateral extent. We are designating the area inundated by extreme high tide because it encompasses habitat areas typically inundated and regularly occupied during the spring and summer when juvenile salmon are migrating in the nearshore zone and relying heavily on forage, cover, and refuge qualities provided by these occupied habitats.”

Excluded from critical habitat for NC steelhead and CC Chinook salmon are: (1) occupied habitat areas on Indian lands; and (2) land owned or controlled by the Department of Defense, or designated for its use, that are identified in the FR notice.

The critical habitat analytical review team determined that the *primary constituent elements* (PCEs) essential for these ESUs (including NC steelhead and CC Chinook salmon) are those sites and habitat components that support one or more life stages, including:

- (1) Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning, incubation and larval development.
- (2) Freshwater rearing sites with: (i) Water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; (ii) Water quality and forage supporting juvenile development; and (iii) Natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks.
- (3) Freshwater migration corridors free of obstruction and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival.
- (4) Estuarine areas free of obstruction and excessive predation with: (i) Water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; (ii) Natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels; and

- (iii) Juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation.

In particular, NMFS found that Humboldt Bay contains PCEs for rearing and migration and was of high conservation value because it provides migratory connectivity for juveniles and adults between high value freshwater spawning and rearing habitat and the ocean (December 10, 2004, 69 FR 71880; September 2, 2005, 70 FR 52488).

The current condition of critical habitat for the listed salmonids is discussed in the *Factors Affecting Critical Habitat* and *Factors Affecting Salmonid Population Decline* sections below. The *Environmental Baseline* section describes habitat conditions within the action area. Furthermore, the *Effects of the Action* section is largely organized around anticipated effects on fish habitat.

3. Factors Affecting Critical Habitat

Studies indicate that in most western states, about 80 to 90 percent of the historic riparian habitat has been eliminated (Norse 1990, California State Lands Commission 1993). Loss of habitat complexity and fragmentation of habitat have also contributed to the decline of salmonids. For example, in national forests within the range of the northern spotted owl in western and eastern Washington, there has been a 58 percent reduction in large, deep pools due to sedimentation and loss of pool-forming structures such as large wood (Forest Ecosystem Management Assessment Team 1993). The California Advisory Committee on Salmon and Steelhead Trout (1988) reported habitat blockages and fragmentation, logging and agricultural activities, urbanization, and water withdrawals as the most predominant problems for anadromous salmonids in California's coastal basins. They identified associated habitat problems for each major river system in California. California Department of Fish and Game (CDFG 1965, Vol. III, Part B) reported that the most vital habitat factor for coastal California streams was Adegradation due to improper logging followed by massive siltation, log jams, *etc.*” It cited road building as another cause of siltation in some areas. It identified a variety of specific critical habitat problems in individual basins, including extremes of natural flows (Redwood Creek and Eel River), logging practices (Mad, Eel, Mattole, Ten Mile, Noyo, Big, Navarro, Garcia, and Gualala Rivers), dams with no passage facilities (Eel and Russian rivers), and water diversions (Eel and Russian Rivers).

B. Species Life History and Population Trends

1. Coho Salmon

a. General Life History

Coho salmon generally exhibit a relatively simple 3-year life cycle. Most coho salmon enter rivers between September and February. Coho salmon river entry timing is influenced by many factors, one of which appears to be river flow. In addition, many small California stream systems have their mouths blocked by sandbars for most of the year except winter. In these

systems, coho salmon and other Pacific salmonid species are unable to enter the rivers until sufficiently strong freshets open passages through the bars (Weitkamp *et al.* 1995). Coho salmon spawn from November to January (Hassler 1987), and occasionally into February and March (Weitkamp *et al.* 1995).

Although each native stock appears to have a unique time and temperature for spawning that theoretically maximizes offspring survival, coho salmon generally spawn at water temperatures within the range of 50-55EF (Bell 1991). Bjornn and Reiser (1991) found that spawning occurs in a few third-order streams, but most spawning activity was found in fourth- and fifth-order streams. Nickelson *et al.* (1992) found that spawning occurs in tributary streams with a gradient of three percent or less. Spawning occurs in clean gravel ranging in size from that of a pea to that of an orange (Nickelson *et al.* 1992). Spawning is concentrated in riffles or in gravel deposits at the downstream end of pools featuring suitable water depth and velocity (Weitkamp *et al.* 1995). The favorable thermal range for coho salmon egg incubation is 50-55EF (Bell 1991). Coho salmon eggs incubate for approximately 35 to 50 days, and start emerging from the gravel 2 to 3 weeks after hatching (Hassler 1987, Nickelson *et al.* 1992). Following emergence, fry move into shallow areas near the stream banks. As coho salmon fry grow, they disperse upstream and downstream to establish and defend territories (Hassler 1987).

Juvenile rearing usually occurs in tributary streams with a gradient of three percent or less, although they may move up to streams of four percent or five percent gradient. Juveniles have been found in streams as small as 3 to 6 feet wide. At a length of 1.5-1.75 inches, the fry may migrate upstream a considerable distance to reach lakes or other rearing areas (Godfrey 1965, Nickelson *et al.* 1992). Rearing requires temperatures of 68EF or less, preferably 53-58EF (Reiser and Bjornn 1979, Reeves *et al.* 1987, Bell 1991). Coho salmon fry are most abundant in backwater pools during spring. During the summer, coho salmon fry prefer pools featuring adequate cover such as large woody debris (LWD), undercut banks, and overhanging vegetation. Juvenile coho salmon prefer to over-winter in large mainstem pools, backwater areas and secondary pools with LWD, and undercut bank areas (Hassler 1987, Heifetz *et al.* 1986). Coho salmon rear in fresh water for up to 15 months, then migrate to the sea as smolts between March and June (Weitkamp *et al.* 1995).

The ideal food channel for maximum coho smolt production would have shallow depth (3-24 inches), fairly swift mid-stream flows (2 ft/sec), numerous marginal back-eddies, narrow width, copious overhanging mixed vegetation (to lower water temperatures, provide leaf-fall, and contribute terrestrial insects), and banks permitting hiding places (Boussu 1954). The early diets of emerging fry include chironomid larvae and pupae (Mundie 1969). Juvenile coho salmon are carnivorous opportunists that primarily eat aquatic and terrestrial insects. They do not appear to pick stationary items off the substratum (Sandercock 1991, Mundie 1969).

Little is known about residence time or habitat use in estuaries during seaward migration, although it is usually assumed that coho salmon spend only a short time in the estuary before entering the ocean (Nickelson *et al.* 1992). Growth is very rapid once the smolts reach the estuary (Fisher *et al.* 1984 *op cit.* Sandercock 1991). While living in the ocean, coho salmon remain closer to their river of origin than do Chinook salmon (Weitkamp *et al.* 1995).

Nevertheless, coho salmon have been captured several hundred to several thousand kilometers away from their natal stream (Hassler 1987). After about 12 months at sea, coho salmon gradually migrate south and along the coast, but some appear to follow a counter-clockwise circuit in the Gulf of Alaska (Sandercock 1991). Coho salmon typically spend two growing seasons in the ocean before returning to their natal streams to spawn as 3 year-olds. Some precocious males, called "jacks," return to spawn after only 6 months at sea.

b. Range-wide (ESU) Status and Trends of SONCC Coho Salmon

Available historical and recent coho salmon abundance information is summarized in the NMFS coast-wide status review (Weitkamp *et al.* 1995). The following excerpt is from this document:

“All coho salmon stocks between Punta Gorda and Cape Blanco are depressed relative to past abundance, but there are limited data to assess population numbers or trends. The main stocks in this region (Rogue River, Klamath River, and Trinity River) are heavily influenced by hatcheries and, apparently, have little natural production in mainstem rivers. The apparent decline in production in these rivers, in conjunction with heavy hatchery production, suggest that the natural populations are not self sustaining. The status of coho salmon stocks in most small coastal tributaries is not well known, but these populations are small. There was unanimous agreement among the biological review team that coho salmon in this ESU are not in danger of extinction but are likely to become endangered in the foreseeable future if present trends continue.”

Brown and Moyle (1991) estimated that naturally-spawned adult coho salmon returning to California streams were less than 1 percent of their abundance at mid-twentieth century, and indigenous, wild coho salmon populations in California did not exceed 100 to 1,300 individuals. Further, they stated that 46 percent of California streams which historically supported coho salmon populations, and for which recent data were available, no longer supported runs.

No regular spawning escapement estimates exist for natural coho salmon in California streams. CDFG (1994 *op cit.* Weitkamp *et al.* 1995) summarized most information for the northern California region of this ESU, and concluded that coho salmon in California, including hatchery populations, could be less than 6 percent of their abundance during the 1940s, and have declined at least 70 percent in the 1960s. Further, it reported that coho salmon populations have been virtually eliminated in many streams, and that adults are observed only every third year in some streams, suggesting that two of three brood cycles may already have been eliminated.

The rivers and tributaries in the California portion of this ESU were estimated to have average recent runs of 7,080 natural spawners and 17,156 hatchery returns, with 4,480 identified as "native" fish occurring in tributaries having little history of supplementation with non-native fish. Combining recent run-size estimates for the California portion of this ESU with Rogue River estimates provides a rough minimum run-size estimate for the entire ESU of about 10,000 natural fish and 20,000 hatchery fish (May 6, 1997, 62 FR 24588).

NMFS (2001) updated the status review for coho salmon from the Central California Coast (CCC) and the California portion of the SONCC ESUs. The following are excerpts of the updated status review:

“In the California portion of the SONCC coho salmon ESU, there appears to be a general decline in abundance, but trend data are more limited in this area and there is variability among streams and years. In the California portion of the SONCC coho salmon ESU, Trinity River Hatchery maintains large production and is thought to create significant straying to natural populations. In the California portion of the SONCC coho salmon ESU, the percent of streams with coho salmon present in at least one brood year has shown a decline from 1989-1991 to the present. In 1989-1991 and 1992-1995, coho salmon were found in over 80 percent of the streams surveyed. Since then, the percentage has declined to 69 percent in the most recent three-year interval.

Both the presence-absence and trend data presented in this report suggest that many coho salmon populations in this ESU continue to decline. Presence-absence information from the past 12 years indicates fish have been extirpated or at least reduced in numbers sufficiently to reduce the probability of detection in conventional surveys. Unlike the CCC ESU, the percentage of streams in which coho salmon were documented did not experience a strong increase in the 1995-1997 period. Population trend data were less available in this ESU, nevertheless, for those sites that did have trend information, evidence suggests declines in abundance.

After considering this information, we conclude that the Southern Oregon/Northern California Coasts ESU is presently not at risk of extinction, but it is likely to become endangered in the foreseeable future. The conclusion is tempered by the fact that population trend data was limited, and further analysis may reveal declines sufficient to conclude that the California portion of this ESU is in danger of extinction.”

Based on the very depressed status of current coho salmon populations discussed above as well as insufficient regulatory mechanisms and conservation efforts over the ESU as a whole, NMFS concluded that the ESU was likely to become endangered in the foreseeable future (May 6, 1997, 62 FR 24588). A more recent status update (Good *et al.* 2005) indicated a continued low abundance with no apparent trends in abundance and possible continued declines in several California populations. The relatively strong 2001 brood year, likely due to favorable conditions in both freshwater and marine environments, was viewed as a positive sign, but was a single strong year following more than a decade of generally poor years (Good *et al.* 2005). Due to no changes in the basis for earlier listing determinations, NMFS listed the species as threatened on June 28, 2005 (70 FR 37160).

2. Steelhead

a. General Life History

Biologically, steelhead can be divided into two basic run-types, based on the state of sexual maturity at the time of river entry and duration of spawning migration (Burgner *et al.* 1992 *op cit.* Busby *et al.* 1996). The stream-maturing type, or summer steelhead, enters freshwater in a sexually immature condition and requires several months in freshwater to mature and spawn. The ocean-maturing type, or winter steelhead, enters freshwater with well-developed gonads and spawns shortly after river entry (August 9, 1996, 61 FR 41541; Barnhart 1986). Variations in migration timing exist between populations. Some river basins have both summer and winter steelhead, while others only have one run-type. South of Cape Blanco, Oregon, both summer and winter steelhead are known to occur in the Rogue, Smith, Klamath, Trinity, Mad, and Eel Rivers, and in Redwood Creek (Busby *et al.* 1996).

Summer steelhead enter fresh water between May and October in the Pacific Northwest (Busby *et al.* 1996, Nickelson *et al.* 1992). They require cool, deep holding pools during summer and fall, prior to spawning in winter through early spring (Nickelson *et al.* 1992).

Winter steelhead enter freshwater between November and April in the Pacific Northwest (Nickelson *et al.* 1992, Busby *et al.* 1996), migrate to spawning areas, and then spawn, generally in April and May (Barnhart 1986). Some adults, however, do not enter some coastal streams until spring, just before spawning (Meehan and Bjornn 1991).

There is a high degree of overlap in spawn timing between populations within an ESU regardless of run type (Busby *et al.* 1996). Difficult field conditions at that time of year and the remoteness of spawning grounds contribute to the relative lack of specific information on steelhead spawning. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (August 9, 1996, 61 FR 41541; Nickelson *et al.* 1992). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996).

Steelhead spawn in cool, clear streams featuring suitable gravel size, depth, and current velocity. Intermittent streams may be used for spawning (Everest 1973, Barnhart 1986). Steelhead enter streams and arrive at spawning grounds weeks or even months before they spawn and are vulnerable to disturbance and predation. Cover, in the form of overhanging vegetation, undercut banks, submerged vegetation, submerged objects such as logs and rocks, floating debris, deep water, turbulence, and turbidity (Giger 1973) are required to reduce disturbance and predation of spawning steelhead. It appears that summer steelhead occur where habitat is not fully utilized by winter steelhead; summer steelhead usually spawn further upstream than winter steelhead (Withler 1966 *op cit.* Busby *et al.* 1996, Behnke 1992).

Steelhead require a minimum depth of 7 inches and a maximum velocity of 8 ft/sec for active upstream migration (Smith 1973). Spawning and initial rearing of juvenile steelhead generally

take place in small, moderate-gradient (generally 3-5 percent) tributary streams (Nickelson *et al.* 1992). A minimum depth of 7 inches, water velocity of 1-3 ft/sec (Thompson 1972, Smith 1973), and clean substrate 0.25-4 inches (Hunter 1973 *op cit.* Bjornn and Reiser 1991, Nickelson *et al.* 1992) are required for spawning. Steelhead spawn in 39-49EF water (Bell 1991).

Depending on water temperature, steelhead eggs may incubate for 1.5 to 4 months before hatching, generally between February and June (Bell 1991). Bjornn and Reiser (1991) noted that steelhead eggs incubate about 85 days at 39EF and 26 days at 54°F to reach 50 percent hatch. Nickelson *et al.* (1992) stated that eggs hatch in 35-50 days, depending upon water temperature.

After 2 to 3 weeks, in late spring, and following yolk sac absorption, alevins emerge from the gravel and begin actively feeding. After emerging from the gravel, fry usually inhabit shallow water along banks of perennial streams. Fry occupy stream margins (Nickelson *et al.* 1992). Older fry establish and defend territories.

Summer rearing takes place primarily in the faster parts of pools, although young-of-the-year (YOY) are abundant in glides and riffles. Winter rearing occurs more uniformly at lower densities across a wide range of fast and slow habitat types. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small in-stream wood. Some older juveniles move downstream to rear in larger tributaries and mainstem rivers (Nickelson *et al.* 1992).

Juvenile steelhead migrate little during their first summer and occupy a range of habitats featuring moderate to high water velocity and variable depths (Bisson *et al.* 1988). Rearing juveniles prefer water temperatures ranging from 54-59°F (Reeves *et al.* 1987). Juvenile steelhead feed on a wide variety of aquatic and terrestrial insects (Chapman and Bjornn 1969), and older juveniles sometimes prey on emerging fry. Steelhead hold territories close to the substratum where flows are lower and sometimes counter to the main stream. From these, they can make forays up into surface currents to take drifting food (Kalleberg 1958 *op cit.* Mundie 1969). Juveniles rear in freshwater from 1 to 4 years (usually 2 years in the California ESUs), then smolt and migrate to the ocean in March and April (Barnhart 1986). Steelhead smolts are usually 6-8 inches total length and migrate to the ocean in the spring (Meehan and Bjornn 1991). Based on incidental purse seine catches, juvenile steelhead tend to migrate directly offshore during their first summer from whatever point they enter the ocean rather than migrating along the coastal belt as salmon do. During the fall and winter, juveniles move southward and eastward (Hartt and Dell 1986 *op cit.* Nickelson *et al.* 1992).

Steelhead typically reside in marine waters for 2 or 3 years prior to returning to their natal stream to spawn as 4- or 5-year olds (August 9, 1996, 61 FR 41541). Populations in Oregon and California have higher frequencies of age-1 ocean steelhead than populations to the north, but age-2 ocean steelhead generally remain dominant (Busby *et al.* 1996). Age structure appears to be similar to other west coast steelhead, dominated by 4-year-old spawners (Busby *et al.* 1996). Some steelhead return to freshwater after only 2 to 4 months in the ocean and are termed "half-pounders" (Snyder 1925). Half-pounders generally spend the winter in freshwater and then out

migrate again the following spring for several months before returning to freshwater to spawn. Half-pounders occur over a relatively small geographic range in southern Oregon and northern California, and are only reported in the Rogue, Klamath, Mad, and Eel Rivers (Snyder 1925, Kesner and Barnhart 1972, Everest 1973, Barnhart 1986).

b. Range-Wide Status and Trends of NC steelhead

Available historical and recent published steelhead abundance are summarized in the NMFS west coast steelhead status review (Busby *et al.* 1996). The following are excerpts from this document:

“Prior to 1960, estimates of abundance specific to this ESU were available from dam counts in the upper Eel River (Cape Horn DamBannual average of 4,400 adult steelhead in the 1930s), the South Fork Eel River (Benbow DamBannual average of 19,000 adult steelhead in the 1940s), and the Mad River (Sweasey DamBannual average of 3,800 adult steelhead in the 1940s).

In the mid-1960s, estimates of steelhead spawning populations for many rivers in this ESU totaled 198,000. The only current run-size estimates for this area are counts at Cape Horn Dam on the Eel River where an average of 115 total and 30 wild adults were reported.

Adequate adult escapement information was available to compute trends for seven stocks within this ESU. Of these, five data series exhibit declines and two exhibit increases during the available data series, with a range from 5.8% annual decline to 3.5% annual increase. Three of the declining trends were significantly different from zero. We have little information on the actual contribution of hatchery fish to natural spawning, and little information on present total run sizes for this ESU. However, given the preponderance of significant negative trends in the available data, there is concern that steelhead populations in this ESU may not be self-sustaining.”

Schiewe (1997b) summarized more recent data on trends in abundance for summer and winter steelhead in the Northern California ESU. The following are excerpts from this document:

“Updated spawner surveys of summer steelhead in Redwood Creek, the south for of the Van Duzen River (Eel River Basin), and the Mad River suggest mixed trends in abundance: the Van Duzen fish decreased by -7.1% from 1980-96 and the Mad River summer steelhead have increased by 10.3% over the same time period. The contribution of hatchery fish to these trends in abundance is not known.

New weir counts of winter steelhead in Prairie Creek (Redwood Creek Basin, Humboldt County) show a dramatic increase (over 36%) in abundance during the period 1985-1992. This increase is difficult to interpret because a major highway

construction project during this time period resulted in intensive monitoring of salmonids in the basin and Prairie Creek Hatchery was funded to mitigate lost salmonid production. Therefore, it is unclear whether the increase in steelhead reflects increased monitoring effort and mitigation efforts or an actual recovery of Prairie Creek steelhead.”

In 2000, NMFS concluded that the status of the population had changed little since the 1997 evaluation. Based on this and a lack of implementation of State conservation measures, NMFS concluded that the Northern California steelhead ESU warrants listing as a threatened species (June 7, 2000, 65 FR 36074). The more recent review of the status of NC steelhead (Good *et al.* 2005) indicated that the ESU is still likely to become endangered.

3. Chinook Salmon

a. General Life History

Of the Pacific salmon, Chinook salmon exhibit arguably the most diverse and complex life history strategies. Healey (1986) described 16 age categories for Chinook salmon, 7 total ages with 3 possible freshwater ages. Two generalized freshwater life-history types were described by Healey (1991): “stream-type” Chinook salmon reside in freshwater for a year or more following emergence, whereas “ocean-type” Chinook salmon migrate to the ocean within their first year.

Chinook salmon mature between 2 and 6+ years of age (Myers *et al.* 1998). Freshwater entry and spawning timing are generally thought to be related to local water temperature and flow regimes (Miller and Brannon 1982). Runs are designated on the basis of adult migration timing. However, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and actual time of spawning (Myers *et al.* 1998).

Run timing for spring-run Chinook salmon in this ESU typically begins in March and continues through July, with peak migration occurring in May and June. Spawning begins in late August and can continue through October, with a peak in September. Historically, spring-run Chinook salmon spawning areas were located in the river headwaters (generally greater than 1,300 feet elevation). Run timing for fall-run Chinook salmon varies depending on the size of the river. Adult Rogue, Upper Klamath, and Eel River fall-run Chinook salmon return to freshwater in August and September and spawn in late October and early November (Stone 1897, Snyder 1931, Nicholas and Hankin 1988, Barnhart 1995). In other coastal rivers and the lower reaches of the Klamath River, fall-run freshwater entry begins later in October, with peak spawning in late November and December, often extending into January (Leidy and Leidy 1984, Nicholas and Hankin 1988, Barnhart 1995). Late-fall or “snow” Chinook salmon from Blue Creek, on the lower Klamath River, were described as resembling the fall-run fish from the Smith River in run and spawning timing, as well as the degree of sexual maturation at the time of river entry (Snyder 1931).

When they enter freshwater, spring-run Chinook salmon are immature and must stage for several months before spawning. Their gonads mature during their summer holding period in freshwater. Over-summering adults require cold-water refuges such as deep pools to conserve energy for gamete production, redd construction, spawning, and redd guarding. The upper limit of the optimal temperature range for adults holding while eggs are maturing is 59-61°F (Hinz 1959). The upper preferred water temperature for spawning adult Chinook salmon is 55-57°F (Reiser and Bjornn 1979). Unusual stream temperatures during spawning, migration, and adult holding periods can alter or delay migration timing, and increase fish susceptibility to diseases. Sustained water temperatures above 80°F are lethal to adults (Cramer and Hammack 1952, CDFG 1998).

Spring-run Chinook salmon eggs generally incubate between October to January, and fall-run Chinook salmon eggs incubate between October and December (Bell 1991). Length of time required for eggs to develop and hatch is dependent on water temperature and is quite variable, typically ranging from 3-5 months. The optimum temperature range for Chinook salmon egg incubation is 45-54°F (Rich 1997). Incubating eggs show reduced egg viability and increased mortality at temperatures greater than 57°F and show 100 percent mortality for temperatures greater than 63°F (Velson 1987). Velson (1987) found that developing Chinook salmon embryos exposed to water temperatures of 36°F or less before the eyed stage experienced 100 percent mortality (CDFG 1998). Emergence of spring- and fall-run Chinook salmon fry begins in December and continues into mid-April (Leidy and Leidy 1984, Bell 1991). Fry use woody debris, interstitial spaces in cobble substrates, and undercut banks as cover (Everest and Chapman 1972). As the fry grow, habitat preferences change. Juveniles move away from stream margins and begin to use deeper water areas with slightly higher water velocities.

Post-emergent fry seek out shallow, nearshore areas with slow current and good cover, and begin feeding on small terrestrial and aquatic insects and aquatic crustaceans. As they grow to 2-3 inches in length, the juvenile salmon move out into deeper, swifter water, but continue to use available cover to minimize the risk of predation and reduce energy expenditure. The optimum range for rearing Chinook salmon fry is 50-55°F (Seymour 1956, Rich 1997) and for fingerlings is 55-61°F (Rich 1997). Data from the Mad River (Sparkman 2002) and nearby Redwood Creek (Sparkman 2003) indicate that emergent Chinook salmon fry develop rapidly following emergence. Over a 15-week period in the spring of 2001, Chinook salmon fry increased in average length from 1.6 inches to 2.6 inches with the bulk of this growth occurring during a 10-week period in May and June (Sparkman 2002). The months of May and June accounted for 91.5 percent of the total captures of migrating YOY Chinook salmon in 2001 (Sparkman 2002).

Chinook salmon populations south of Cape Blanco all exhibit an ocean-type life history. The majority of fish emigrate to the ocean as sub yearlings, although yearling smolts can constitute up to approximately a fifth of out-migrants from the Klamath River Basin, and to a lesser proportion in the Rogue River Basin. However, the proportion of fish which smolted as sub-yearling vs. yearling varies from year to year (Snyder 1931, Schluchter and Lichatowich 1977, Nicholas and Hankin 1988, Barnhart 1995). This fluctuation in age at smoltification is more characteristic of an ocean-type life history. Furthermore, the low flows, high temperatures, and barrier bars that develop in smaller coastal rivers during the summer months would favor an

ocean-type (sub-yearling smolt) life history (Kostow 1995). Ocean-type juveniles enter saltwater during one of three distinct phases. Immediate fry migrate to the ocean soon after yolk resorption at 1.2-1.8 inches in length (Lister *et al.* 1971 *op cit.* Myers *et al.* 1998, Healey 1991). In most river systems, however, fry migrants, which migrate at 50-150 days post-hatching, and fingerling migrants, which migrate in the late summer or autumn of their first year, represent the majority of ocean-type emigrants. Stream-type Chinook salmon migrate during their second or, more rarely, their third spring (Healey 1991 *op cit.* Groot and Margolis 1991). Under natural conditions, stream-type Chinook salmon appear to be unable to smolt as sub yearlings (Healey 1991 *op cit.* Groot and Margolis 1991).

The diet of out-migrating ocean-type Chinook salmon varies geographically and seasonally, and feeding appears to be opportunistic (Healey 1991 *op cit.* Groot and Margolis 1991). Aquatic insect larvae and adults, *Daphnia*, amphipods (*Eogammarus* and *Corophium spp.*), and *Neomysis* have been identified as important food items (Kjelson *et al.* 1982, Healey 1991 *op cit.* Groot and Margolis 1991).

Juvenile stream- and ocean-type Chinook salmon have adapted to different ecological niches. Ocean-type Chinook salmon tend to utilize estuaries and coastal areas more extensively for juvenile rearing. In general, the younger (smaller) juveniles are at the time of emigration to the estuary, the longer they reside there (Kjelson *et al.* 1982, Levy and Northcote 1982 *op cit.* Myers *et al.* 1998, Healey 1991 *op cit.* Groot and Margolis 1991). Stream-type juveniles are much more dependent on freshwater stream ecosystems because of their extended residence in these areas. A stream-type life history may be adapted to those watersheds, or parts of watersheds, that are more consistently productive and less susceptible to dramatic changes in water flow, or which have environmental conditions that would severely limit the success of sub yearling smolts (Miller and Brannon 1982, Healey 1991 *op cit.* Groot and Margolis 1991).

In preparation for their entry into a saline environment, juvenile Chinook salmon undergo physiological transformations known as smoltification that adapt them for their transition to salt water (Hoar 1976). These transformations include different swimming behavior and proficiency, lower swimming stamina, and increased buoyancy that also make the fish more likely to be passively transported by currents (Saunders 1965, Folmar and Dickhoff 1980, Smith 1982). In general, smoltification is timed to be completed as fish are near the fresh water to salt water transition. Too long a migration delay after the process begins is believed to cause the fish to miss the “biological window” of optimal physiological condition for the transition (Walters *et al.* 1978). The optimal thermal range for Chinook salmon during smoltification and seaward migration is 50-55°F (Rich 1997).

Chinook salmon spend between 1 and 4 years in the ocean before returning to their natal streams to spawn (Myers *et al.* 1998). Fisher (1994) reported that 87 percent of returning spring-run adults are 3-year-olds based on observations of adult Chinook salmon trapped and examined at Red Bluff Diversion Dam on the Sacramento River between 1985 and 1991.

b. Range-wide (ESU) Status and Trends of CC Chinook Salmon

The coastal drainages south of Cape Blanco, Oregon are dominated by the Rogue, Klamath, and Eel Rivers. The Chetco, Smith, Mad, Mattole, and Russian Rivers and Redwood Creek are smaller systems that contain sizable populations of fall-run Chinook salmon (Campbell and Moyle 1990, Oregon Department of Fish and Wildlife 1995). Presently, spring runs are found in the Rogue, Klamath, and Trinity Rivers. Additionally, a vestigial spring run may still exist on the Smith River (Campbell and Moyle 1990, U.S. Department of Agriculture-Forest Service 1995). Historically, fall-run Chinook salmon were predominant in most coastal river systems south to the Ventura River. However, their current distribution only extends to the Russian River (Healey 1991 *op cit.* Groot and Margolis 1991). There have also been spawning fall-run Chinook salmon reported in small rivers draining into San Francisco Bay (Nielsen *et al.* 1994). Available historical and recent published Chinook salmon abundance information are summarized in Myers *et al.* (1998). The following are excerpts from this document:

“Estimated escapement of this ESU was estimated at 73,000 fish, predominantly in the Eel River (55,500) with smaller populations in: Redwood Creek, Mad River, Mattole River (5,000 each), Russian River (500), and several small streams in Del Norte and Humboldt Counties.

Within this ESU, recent abundance data vary regionally. Dam counts of upstream migrants are available on the South Fork Eel River at Benbow Dam from 1938-1975. Counts at Cape Horn Dam, on the upper Eel River are available from the 1940s to the present, but they represent a small, highly variable portion of the run. No total escapement estimates are available for this ESU, although partial counts indicate that escapement in the Eel River exceeds 4,000.

Data available to assess trends in abundance are limited. Recent trends have been mixed, with predominantly strong negative trends in the Eel River Basin, and mostly upward trends elsewhere. Previous assessments of stocks within this ESU have identified several stocks as being at risk or of concern. Nehlsen *et al.* (1991) identified seven stocks as at high extinction risk and seven stocks as at moderate extinction risk. Higgins *et al.* (1992) provided a more detailed analysis of some of these stocks, and identified nine Chinook salmon stocks as at risk or of concern. Four of these stock assessments agreed with Nehlsen *et al.* (1991) designations, while five fall-run Chinook salmon stocks were either reassessed from a moderate risk of extinction to stocks of concern (Redwood Creek, Mad River, and Eel River) or were additions to the Nehlsen *et al.* (1991) list as stocks of special concern (Little and Bear Rivers). In addition, two fall-run stocks (Smith and Russian Rivers) that Nehlsen *et al.* (1991) listed as at moderate extinction risk were deleted from the list of stocks at risk by Higgins *et al.* (1992), although the U.S. Fish and Wildlife Service reported that the deletion for the Russian River was due to a finding that the stock was extinct.”

Observed widespread declines in abundance and the present distribution of small populations with sometimes sporadic occurrences contribute to the risks faced in this ESU. Based on this information, NMFS concluded that the CC Chinook salmon ESU is likely to become endangered in the near future (September 16, 1999, 64 FR 50394). More recent information for the status of CC Chinook salmon (Good *et al.* 2005) continues to support this conclusion.

C. Factors Responsible for Salmonid Population Declines

Salmonids on the west coast of the United States have experienced declines in abundance in the past several decades as a result of loss, damage or change to their critical habitat. The factors for decline among populations of SONCC coho salmon, CC Chinook salmon, and NC steelhead are similar and are discussed collectively below. Factors affecting only a particular species are highlighted, where appropriate. For more detailed discussions on factors for decline of SONCC coho salmon, refer to Weitkamp *et al.* (1995) as updated by Schiewe (1997a) and CDFG (2002). Factors influencing CC Chinook salmon declines are discussed in Myers *et al.* (1998). Factors causing NC steelhead declines are described in Busby *et al.* (1996).

1. Timber Harvest

Timber harvest and associated activities occur over a large portion of the ESUs/DPS of the affected species. Timber harvest has caused widespread increases in sediment delivery to channels through both increased landsliding and surface erosion from harvest units and log decks. Much of the riparian vegetation has been removed, reducing future sources of LWD needed to form and maintain stream habitat that salmonids depend on during various life stages. Cumulatively, the increased sediment delivery and reduced woody debris supply have led to widespread impacts to stream habitats and salmonids. These impacts include reduced spawning habitat quality, loss of pool habitat for adult holding and juvenile rearing, loss of velocity refugia, and increases in the levels and duration of turbidity which reduce the ability of juvenile fish to feed and, in some cases, may cause physical harm by abrading the gills of individual fish. These changes in habitat have led to widespread decreases in the carrying capacity of the streams that support salmonids.

2. Road Construction

Road construction, whether associated with timber harvest or other activities, has caused widespread impacts to salmonids (Furniss *et al.* 1991). Where roads cross salmonid-bearing streams, improperly placed culverts have blocked access to many stream reaches. Landsliding and chronic surface erosion from road surfaces are large sources of sediment across the affected species' ranges. Roads also have the potential to increase peak flows with consequent effects on the stability of stream substrates and banks. Roads have led to widespread impacts on salmonids by increasing the sediment loads. The consequent impacts on habitat include reductions in spawning, rearing and holding habitat, and increases in turbidity. These effects are similar to those described for timber harvest above.

3. Hatcheries

Artificial propagation is also a factor in the decline of salmonids due to the genetic impacts on indigenous, naturally-reproducing populations, disease transmission, predation of wild fish, depletion of wild stock to enhance brood stock, and replacement rather than supplementation of wild stocks through competition and the continued annual introduction of hatchery fish.

Artificial propagation and other human activities such as harvest and habitat modification can genetically change natural populations so much that they no longer represent an evolutionarily significant component of the biological species (Waples 1991). NMFS specifically identified the past practices of the Mad River Hatchery as potentially damaging to NC steelhead. CDFG out-planted non-indigenous Mad River Hatchery brood stocks to other streams within the ESU. CDFG also attempted to cultivate a run of non-indigenous summer steelhead within the Mad River, but ended these practices in 1996.

4. Water Diversions

Streamflow diversions are common throughout the species' ranges. Unscreened diversions for agricultural, domestic and industrial uses are a significant factor for salmonid declines in many basins. Reduced streamflows due to diversions reduce the amount of habitat available to salmonids and can degrade existing water quality, particularly where return flows enter the river. Reductions in the quantity of water in a given stream reach will reduce the carrying capacity of the reach. Where warm return flows enter the stream, fish may seek reaches with cooler water, thus increasing competitive pressures in other areas.

5. Predation

Predation was not believed to have been a major cause in the species decline, however, it may have had substantial impacts in local areas. For example, Higgins *et al.* (1992) and CDFG (1994 *op cit.* Weitkamp *et al.* 1995) reported that Sacramento River pikeminnow have been found in the Eel River Basin and are considered a major threat to native salmonids. Furthermore, California sea lions and Pacific harbor seals, which occur in most estuaries and rivers where salmonid runs occur on the West Coast, are known predators of salmonids. However, salmonids appear to be a minor component of the diet of marine mammals (Scheffer and Sperry 1931, Jameson and Kenyon 1977, Graybill 1981, Brown and Mate 1983, Roffe and Mate 1984, Hanson 1993).

6. Disease

Infectious disease is one of many factors that can influence adult and juvenile salmonid survival. Salmonids are exposed to numerous bacterial, protozoan, viral, and parasitic organisms in spawning and rearing areas, hatcheries, migratory routes, and the marine environment. Very little current or historical information exists to quantify changes in infection levels and mortality rates attributable to these diseases for salmonids. However, studies suggest that naturally spawned fish tend to be less susceptible to pathogens than hatchery-reared fish (Sanders *et al.* 1992).

7. Sport and Commercial Harvest

Commercial and recreational ocean salmon fisheries result in adult mortality of listed Chinook salmon and coho salmon originating from the action area. Steelhead are rarely caught in the ocean fisheries. Ocean salmon fisheries are managed by NMFS to achieve Federal conservation goals for west coast salmon in the Pacific Coast Salmon Fishery Management Plan (FMP). The goals specify numbers of adults that must be allowed to spawn annually, or maximum allowable adult harvest rates. The key stocks in California are Klamath River fall-run Chinook salmon and Sacramento River fall-run Chinook salmon. In addition to the FMP goals, salmon fisheries must meet requirements developed through NMFS intra-agency section 7 consultations.

Reliable harvest rates are available for Klamath River fall-run Chinook salmon, which are not part of the CC Chinook salmon ESU, as described in NMFS (2000). Beginning in 1991, ocean harvest rates on Klamath River fall-run Chinook salmon declined from an average of 45 percent (1981-1990) to an average of 12 percent (1991-2002). The reduction in ocean harvest was a result of implementing the Federally-reserved fishing rights of the Yurok and Hoopa Valley Indian Tribes of the Klamath Basin, quantified in 1993 as 50 percent of the available harvest. NMFS (2000) required that the pre-season estimated ocean harvest rates on age-4 Klamath River fall-run Chinook salmon (used as an indicator for harvest rates on CC Chinook salmon) not exceed 16 percent. However, postseason harvest rates have exceeded the estimated 16 percent harvest rate for the last 3 years (27 percent in 2003; 50.8 percent in 2004; and 23.9 percent in 2005).

In addition, the total harvest rate on Klamath River fall-run Chinook salmon, including ocean commercial and recreational, river recreational, and tribal harvest is substantially higher than the ocean harvest rate alone. For example, the fraction of the age-4 ocean abundance taken by ocean and river fisheries between 1998 and 2002 ranged from 27 to 40 percent, two to four times the rate of ocean harvest alone (Pacific Fishery Management Council 2003). Total harvest rates on CC Chinook salmon would be closer to the ocean harvest rate for Klamath River fall-run Chinook salmon, since no tribal fisheries occur in the CC Chinook salmon ESU spawning area, and no retention of fish is permitted in recreational river fisheries in the CC Chinook salmon ESU spawning area, mortality being limited to that associated with hook and release fishing.

The Reasonable and Prudent Alternative (RPA) in NMFS (2000), like all RPAs, is intended to avoid jeopardizing the continued existence of the species; it is not designed to ensure recovery of the species. NMFS (2000) concluded that the incidental take of CC Chinook salmon in ocean fisheries between 1996 and 1999 appeared to be sufficiently low as to allow persistence of CC Chinook salmon populations at low abundance levels. The FMP RPA was designed to prevent ocean harvest rates from rising substantially above those experienced by the population between 1996 and 1999. NMFS (2000) noted that the uncertainty regarding abundance trends of CC Chinook salmon populations and the absence of reliable estimates of ocean harvest rates for CC Chinook salmon make it difficult to assess the potential for CC Chinook salmon populations to recover under the current levels of fishing mortality. Under these conditions, any action that reduces the viability of the CC Chinook salmon population in ways not anticipated by previous

biological opinions must be carefully considered to ensure that the combined effects of the actions do not result in a level of take that would jeopardize the population. The exorbitant harvest rates for the last 3 years have resulted in a reinitiation of consultation so as NMFS can reevaluate the ocean harvest fisheries impacts on CC Chinook salmon.

In addition to the reduction in numbers of spawners, ocean salmon fisheries may reduce the viability of Chinook salmon populations through negative effects on demographics. The sequential interception of immature fish by ocean fisheries results in a reduction in the proportion of a cohort that spawns as older, larger fish. The reduction in the average age of spawning would be further intensified by genetic changes in the population due to the heritability of age of maturation (Ricker 1980, Hankin and McKelvey 1985, Hankin and Healey 1986). The higher productivity of larger and older female Chinook salmon results from the larger size and number of eggs they carry (Healey and Heard 1984) as well as their ability to spawn in larger substrates and create deeper egg pockets (Van den Berghe and Gross 1984, Ricker 1980, Shelton 1955). This reduces scour potential, which may be especially important to the productivity of redds in areas subject to high sediment loads and scour.

Ocean exploitation rate estimates are available for tagged hatchery coho salmon from the Klamath, Trinity, and Rogue Rivers and serve as an index for the impact rates on SONCC coho salmon. NMFS (1999) requires that management measures developed under the FMP achieve an ocean exploitation rate on Rogue/Klamath hatchery coho salmon stocks of no more than 13 percent. The mortality is a result of post-release mortality associated with mark selective fisheries for coho salmon off Washington and Oregon and Chinook salmon fisheries. Retention of coho salmon is prohibited off California.

IV. ENVIRONMENTAL BASELINE

The environmental baseline is an analysis of the effects of past and ongoing human and natural factors leading to the current status of the species within the action area. The environmental baseline includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area (50 CFR § 402.02), and a summary of the status of threatened and endangered species in the action area.

The action area includes Salmon Creek and the surrounding 197 acres of wetlands on the Refuge property, as well as Hookton Slough and Humboldt Bay downstream to its confluence with the Pacific Ocean. Coho salmon, Chinook salmon, and steelhead occupy Salmon Creek, Hookton Slough, and Humboldt Bay.

A. Factors Affecting Salmonids in the Action Area

The Final Lower Salmon Creek Delta Salmonid Habitat Enhancement Opportunities report (PCFWWRA *et al.* 2003) describes the historic usage of the Salmon Creek Delta:

“In the 1850s, when settlers of European origin began arriving in Humboldt Bay, people of the Wiyot tribe inhabited the surrounding lands. The tribe’s population was estimated to be about 1,000 persons in the 1850’s (Barnhart et al., 1992). The Wiyot maintained a seasonal fishing village adjacent to the Salmon creek Delta, and tribal history places South Bay as one of their best fishing areas (Nina Hapner with Table Bluff Rancheria, Per. Comm 2/13/02 meeting).”

“Growth in the logging industry along Salmon Creek in the 1880s initiated the modification of the delta area. To accommodate for the influx of lumber, the Hookton channel was dredged in 1883 (ACOE, 1977). This became one of the main channels in Sough Bay, running past the lumber outpost of Field’s Landing.

In 1901 the Northwestern Pacific Railroad was completed. It ran along the eastern margins of Humboldt Bay and led to a rapid increase in diking and filling of saltmarsh. The construction of Highway 101 in 1927 also aiding in the reclamation effort, with the fill used to build the road functioning as an additional levee in numerous locations around the bay. By then most of the saltmarsh along the eastern shores of the bay had been diked, drained and converted to agricultural lands. The more than 7,000 acres of saltmarsh that had historically existed in Humboldt Bay in 1870 had been reduced to less than 970 acres by 1980 (Shapiro [and Associates, Inc.] 1980).

The Salmon Creek Delta did not escape reclamation (Figure 3.2 [not shown]). In 1900, the Z. Russ and Sons Company, created a reclamation district for 1,500 acres of saltmarsh within the Salmon Creek Delta. By 1907 hundreds of cattle were pastured on newly reclaimed lands and the Z. Russ and Sons Company requested to construct additional levees to increase their pasturelands (Van Kirk, 1998).

During the conversion of saltmarsh to agricultural lands, Salmon Creek and its former tributary, Willow Brook, were channelized. Prior to agricultural conversion, Salmon Creek’s main channel flowed north through White Slough. However, during the conversion the main channel was relocated to exit directly into Hookton Slough through a set of tidegates. A series of irrigation ditches and three diversion structures were also constructed to use water series of irrigation ditches and three diversion structures were also constructed to use from Salmon Creek for sub-irrigating pasture and farmlands and provide drinking water for livestock during dry months. The system of ditches also maximized drainage and was operated to promote siltation within the lower portions of the ranch in an effort to raise the land’s overall elevation.

In September 1971 proposed refuge boundaries were established, which included the Salmon Creek Delta. In 1988 the land was purchased by the Federal Government and placed under the management of USFWS.”

In addition, Laird (2006) describes the hydrology of Salmon Creek within the watershed and specifically within the action area:

“Salmon Creek, a tributary to Humboldt Bay, drains an 18 square mile watershed to Hookton Slough. Peak flows in Salmon Creek generally occur from November through March. This stream rises and falls rapidly in response to rainfall. The average annual flood (1.2 year recurrence interval) is approximately 1,100 cubic feet per second (cfs). During the low flow season, Salmon Creek’s discharge can drop to less than 1.0 cfs.

In the project action area there are three tide gate structures (see Figure 3 [not shown]). In the 1980s, one of the top-hinged flaps in a three chamber tide gate at the mouth of Salmon Creek was modified by cutting an opening (fish door) in the flap to provide fish access from Humboldt Bay to Salmon Creek. Consequently, Salmon Creek has a muted tide cycle that fluctuates 4.2 feet (MHHW to MLLW) compared with Hookton Slough’s tidal fluctuations of 6.85 feet. The other two tidegates on Hookton Slough prevent salt water intrusion in the Hookton Slough Unit and adjacent private lands while allowing for the drainage of flood flows derived from overbank flows upstream on Salmon Creek. There is one diversion structure in the project action area known as first diversion, but it is no longer utilized to divert flows.

There is continual exchange of salt water between Hookton Slough and Salmon Creek due to the “fish door” in one of the flaps of the 3 chambered tide gate, which is also augmented by another of the flaps being without a bottom board which creates an 8 inch wide opening. The inflow of tidal water through both the “fish door” and the damaged tide flap creates a muted tide cycle upstream of the Salmon Creek tide gate. At about a 2 foot tide elevation, the inflow begins to overtop the tidal channels within the overflow area in the lower portion of the estuary. At this point the rate of inflow through the tide gate is not adequate to keep pace with the rising water levels in Hookton Slough. Consequently, a muted tide cycle within the estuary develops. During incoming tides, water levels in Salmon Creek estuary rise much slower than that experienced in Hookton Slough. Additionally, water levels continue to rise in the estuary even after the tide begins to recede in the slough. Not until water levels within the slough drop below that existing in the estuary do waters begin to recede upstream of the tide gate. Because of these unusual tidal dynamics, the estuarine channels upstream of the tide gate experience much slower currents during the incoming tides then during outgoing tides. These swift outgoing currents promote efficient routing of sediment through the lower portion of Salmon Creek estuary and into the Bay. Estimated tidal stages (NAVD88) in the Salmon Creek project area are: MHHW = 3.41 feet, Mean High Water (MHW) = 3.03 feet, MLW = 1.75 feet, and MLLW = -0.61 feet. As can be seen from the thalweg profile of Salmon Creek, the lower estuary reach (0 to 1,900 feet) is tidal at all tides. The knick point at the lower boundary of the upper estuary reach (1,900 feet to 4,400 feet) is overtopped by

tides of greater than 1.5 feet. Since the muted high tide occasionally reaches 4.0 feet, it is likely that during certain tidal conditions the backwater effects could extend beyond the steep gradient reach (approximately 3.9 foot elevation) just below the first diversion. At the peak of high tide, a backwater effect can be observed at the upper tidal boundary but no accompanying rise in salinity has been measured.

As Salmon Creek emerges from the coastal hills, it flows through a low-lying valley that Highway 101 transects. Overbank flow, both upstream and downstream of the highway, is a regular occurrence. Due to the overall slope of the topography upstream, floodwaters in the low-lying valley generally flow north, away from the channel. As a result, inundation of the highway, although infrequent, occurs near Cattail Creek instead of at the Salmon Creek crossing. Once below the highway, Salmon Creek crosses under Loleta Drive and then Hookton Road. Streamflow typically overtops the channel banks within this short reach several times each year. Swift moving water can cover the roadway and bridge-deck and flow down Loleta Drive and through the adjacent dairy before crossing Hookton Road (see Figure 6 [not shown], Existing flow paths of Salmon Creek floodwaters within the Refuge and adjacent parcels (PCFWWRA 2003)). A levee begins to run along the left bank of Salmon Creek immediately downstream of Hookton Road. Just as it enters the Refuge, the stream channel turns west following the Refuge property boundary through a straight leveed channel.

In the late 1990s, the former landowner breached a small portion of the levee just below the Hookton Road Bridge in an effort to reduce upstream flooding. Recently, that breach has been filled but there are now two new breaches in the levee farther downstream. These breaches allow floodwaters to exit the channel and flow west across the adjacent pasture/seasonal freshwater wetland. The floodwaters eventually reach the Refuge and drain through the tide gate at the end of Hookton Slough. The floodwater volume is often so great that it overwhelms the first tide gate and continues flowing along the southern levee to the next two tide gates. From Hookton Road to the Refuge boundary floodwaters overtop the east bank and flow north until they enter Cattail Creek. In the straight channelized reach of stream on the Refuge, floodwaters barely overtop the right bank levee to flow into the adjacent field and fill seasonal ponds. At the end of this reach the stream passes uninterrupted through the first diversion structure where floodwaters overtop the flashboards several times a year. These waters fill the diversion ditch that runs to both Cattail Creek and Willow Brook. As a result, high flow events in Salmon Creek provide a substantial amount of freshwater to the seasonal wetlands within other portions of the Refuge. The water provided by these overbank flows is relied upon as a critical part of Refuge operations, creating seasonal freshwater habitat for overwintering and migratory waterbirds. Downstream of the first diversion, overbank flow from Salmon Creek is separated from the rest of the Refuge by the Salmon-Cattail Levee that runs from the middle

diversion to the Bay Levee (see Figure 6 [not shown]). This levee separates Cattail Creek from the Salmon Creek system, directing Cattail Creek into Long Pond rather than flowing into Salmon Creek.

Downstream of the first diversion, the stream becomes tidally influenced (upper estuary) as it flows through a meandering channel that was constructed in 1993, eventually reaching the lower estuary and the tide gate at Hookton Slough. In the upper estuary, overbank flow occurs regularly even though substantial portions of the flood flow exit Salmon Creek upstream at the levee breaches and first diversion. Overbank flow in this reach occurs prior to overtopping the flashboards or flowing through the breached levee upstream.”

Increased sedimentation within Salmon Creek has resulted from land use practices such as logging, road building, and livestock grazing. Land use within the lower portion of the watershed consists mostly of pasture for livestock grazing while the upper watershed consists mostly of redwood and Douglas fir forests (PCFWWRA 2003). A majority of the forests were logged in the early 1900s, and again in the 1940s, which included extensive road building in the watershed (PCFWWRA 2003). Logging continues in the upper watershed today.

Aside from the proposed Project, the Refuge is also planning to reroute the ditched portion of Salmon Creek within the estuary in the next year or two. The future project will relocate a segment of the creek to create a meandering channel to improve habitat complexity and channel stability which will provide further benefits to salmonids. In addition, the old Vance Dairy property just upstream of the Refuge property is planning a restoration project in Salmon Creek that will reduce flooding and consequent salmonid stranding, as well as improve habitat complexity.

B. Status of Salmonids in the Action Area

A memorandum from CDFG on a proposed Timber Harvest Plan (McLeod 1991) stated the following on habitat conditions and salmonid presence within Salmon Creek:

“Little survey data has been collected on Salmon Creek by the Eureka Office. What information does exist indicates that even though Salmon Creek has degraded habitat, it is an important salmonid producer to Humboldt Bay. The most recent stream survey was conducted by Carl Harral et al. in 1984. He surveyed from the Highway 101 bridge to the headwaters, a distance of over 9 miles. The lowermost 1.25 miles contained minimal quality spawning gravel, and had poor streambank stability with a substantial layer of fine sediment predominating. Bottom composition was comprised of an estimated 55 percent fines. In the middle section to the Pacific Lumber Company bridge six miles upstream spawning habitat was poor with the best being upstream of the Walsh property bridge. Gravel was of good quality but was silted and compacted. Estimated bottom composition ranged from 35 to 55 percent sand and silt. Streambank stability was generally poor. Rearing habitat was rated poor to good,

with quality and diversity increasing above the Walsh bridge. The upper section above the Pacific Lumber Company bridge had better rearing conditions and fairly stable streambanks. Most pools were heavily silted however. Spawning gravels contained an estimated 40 percent fines....

In April 1988 a spawning escapement survey was done by Larry Preston et al. in a three mile section below the Pacific Lumber Company bridge. A total of 62 salmon redds were counted and coho young-of-year were abundant throughout most of the survey. In May 1988, 15,000 coho fry were released at the Pacific Lumber Company bridge from the Humboldt Fish Action Council rearing program. I spoke with Kevin Forester, manager of the Humboldt Bay National Wildlife Refuge about the tide gate in lower Salmon Creek. It passes adult salmonids now and will be further improved in the near future.”

Salmon Creek once supported abundant runs of anadromous salmonids [Redwood Community Action Agency (RCAA) and Humboldt Bay Watershed Advisory Committee (HBWAC) 2005]. Inconsistent monitoring over the last 16 years documents small numbers of coho salmon, Chinook salmon, and steelhead. Table 2, from RCAA and HBWAC (2005), summarizes data from 1989 to 1996.

In addition, juvenile steelhead were documented in the Salmon Creek estuary and in Hookton Slough in 2001, 2003 and 2005, and juvenile coho salmon were documented in the Salmon Creek estuary in 2002 and 2003 (Wallace 2005). Wallace (2005) indicated that the seined steelhead spent the year in the lower estuary due to mark and recapture of 50 percent of the total steelhead catch. PCFWRA documented 52 redds and 75 adult coho salmon during 2005 spawner surveys (Farro 2005).

Table 2. Migrant Trapping Data in the Humboldt Bay National Wildlife Refuge (RCAA and HBWAC 2005)

Spawning Season	Total Number Adults Observed (Live and Dead)			Total Numbers Juveniles Observed			Source
	Chinook	Coho	Steelhead	Chinook	Coho	Steelhead	
1989						149	USFWS
1989						37	CDFG
1990	3	16	12				USFWS
1990						12	CR
1991	17	23	41				USFWS
1991-1992	1	1	17				USFWS
1992-1993	1	15	17				USFWS
1994	1	6	19				HBNWR
1995	5	11	20				HBNWR
1996					34	28	SRC

USFWS=United States Fish and Wildlife Service; CDFG=California Department of Fish and Game; CR=College of the Redwoods; HBNWR=Humboldt Bay National Wildlife Refuge; SRC=Simpson Resource Company

V. EFFECTS OF THE ACTION

NMFS provided an overview of the Project in the *Description of the Proposed Action* section of this Opinion. In the *Status of the Species* and *Critical Habitat* sections of this Opinion, NMFS provided an overview, at the ESU scale, of the status and trends of SONCC coho salmon, CC Chinook salmon, NC steelhead, and their designated critical habitats. In the *Environmental Baseline* section of this Opinion, NMFS summarized the effects of past and present Federal, State, local and private activities on SONCC coho salmon, CC Chinook salmon, NC steelhead, and their designated critical habitats within and surrounding the action area. The *Environmental Baseline* section established that anthropogenic activities upstream of and within the action area have significantly negatively affected SONCC coho salmon, CC Chinook salmon and NC steelhead, and their designated critical habitats, and the distribution and abundance of these species in the action area.

In this section of the Opinion, as required by the ESA and its implementing regulations (50 CFR Part 402), NMFS assesses the direct and indirect effects of the proposed action and the effects of any interrelated and interdependent actions on SONCC coho salmon, CC Chinook salmon and NC steelhead, and their designated critical habitats. The purpose of this assessment is to determine if the proposed action is likely to have effects on SONCC coho salmon, CC Chinook salmon, or NC steelhead that appreciably reduce their likelihood of both survival and recovery in the wild (the jeopardy standard identified in 50 CFR 402.02), or destroy or adversely modify SONCC coho salmon, CC Chinook salmon, and NC steelhead critical habitats.

Project activities that may cause adverse effects to salmonids and their habitats in the action area include dewatering and associated fish relocation, changes in tidal prism from tide gate modification, removal and modification of riparian vegetation, and sediment contribution and mobilization. This *Effects of the Action* section will address each of these Project components and will discuss their impacts on SONCC coho salmon, CC Chinook salmon, NC steelhead, and their critical habitats.

A. Direct Effects

1. Capture and Relocation Activities

Before a Project site is dewatered, a fish barrier will be installed and a qualified biologist will capture and relocate fish away from the Project work site to minimize direct mortality and the possible impact of take of listed species. Fish in the immediate Project area will be captured by seine net prior to and following installation of the fish barriers, and then transported and released to a suitable location. Fish barriers will be installed with a vibratory plate, and once fish are relocated, the area will be pumped dry. The pump will be screened with a fine mesh to prevent entrainment of juvenile salmonids, and a qualified biologist will be on hand to rescue any stranded fish and relocate them to a more preferential location.

Relocation activities do have some associated risks to fish, including stress, disease transmission, injury, or death. The amount of unintentional injury and mortality attributable to fish capture varies widely depending on the method used, the ambient conditions, and the expertise and

experience of the field crew. Although sites selected for relocating fish should have similar water temperature as the capture site and should have ample habitat, in some instances, relocated fish may endure short-term stress from crowding at the relocation sites. Relocated fish may also have to compete with other fish, causing increased competition for available resources, such as food and habitat. Some of the fish released at the relocation sites may choose not to remain in these areas and may move either upstream or downstream to areas that have more habitat and a lower density of fish. As each fish moves, competition remains either localized to a small area or quickly diminishes as fish disperse.

Data to precisely quantify the amount of steelhead, coho salmon, or Chinook salmon that will be relocated prior to construction are not available. Relocation activities will occur when juvenile salmonids may be over-summering in the estuary. However, because flows will be low during construction activities (approximately 1 cfs with an ebbing tide during dewatering), and sampling in 2005 found 14 steelhead but no coho salmon or Chinook salmon in the estuary during the time when Project activities will be implemented (Wallace 2005), NMFS does not expect many fish to be present during dewatering and relocation activities. For these reasons, in coordination with a qualified biologist conducting seine netting, NMFS expects direct effects to juvenile salmonids during capture and relocation activities to be minimized.

2. Dewatering

NMFS anticipates temporary changes in streamflow within and downstream of the Project site during dewatering activities. These fluctuations in flow are anticipated to be small, gradual, and short-term. Streamflow in the vicinity of the Project site should be the same as free-flowing conditions, except during dewatering and at the dewatered reach where streamflow is bypassed. Streamflow diversion and Project work area dewatering are expected to cause temporary loss, alteration, and reduction of aquatic habitat. Streamflow diversions could harm individual rearing juvenile steelhead, coho salmon, or Chinook salmon by concentrating or stranding them in residual wetted areas before they are relocated (Cushman 1985). Rearing steelhead, coho salmon, or Chinook salmon could be killed or injured if crushed during installation of the fish barriers, though direct mortality is expected to be minimal due to a juveniles' flight response and because the area will be seined prior to installation. Juvenile salmonids that avoid capture in the Project work area will die during dewatering activities. NMFS expects that the number of juvenile salmonids that will be killed as a result of stranding during dewatering activities will be few, if any.

Benthic (*i.e.*, bottom dwelling) aquatic macroinvertebrates within the Project site may be killed, or their abundance reduced, when creek habitat is dewatered (Cushman 1985). However, effects to the aquatic macroinvertebrate population resulting from streamflow diversions and dewatering will be temporary because construction activities will be relatively short-lived, and rapid recolonization (about 1 to 2 months) of disturbed areas by macroinvertebrates is expected following rewatering (Cushman 1985, Thomas 1985, Harvey 1986). Based on the foregoing, the loss of aquatic macroinvertebrate prey as a result of dewatering activities is not expected to negatively affect NC steelhead, SONCC coho salmon, or CC Chinook salmon or their critical habitats.

B. Indirect Effects

1. Vegetation Modification

Increasing the tidal prism will increase the mean higher high water elevation by 1 foot, inundating surfaces up to 5 feet in elevation. This increase will result in a gain of 8.8 acres of mudflat and 13.0 acres of salt marsh, as well as a loss of 21.8 acres of freshwater wetland/riparian habitat. The loss of riparian vegetation during the habitat transition is expected to be insignificant because the riparian corridor along the Salmon Creek channel is rooted at 6.5 feet or higher. This habitat alteration is expected to return the Project area to a more functional estuary environment and is expected to result in insignificant effects to the listed salmonids or their critical habitats.

Long-term channel adjustments due to the removal of the knick point and the increase in tidal prism is expected to result in Salmon Creek becoming deeper and wider. Estimated increases in channel width range from 2 feet to greater than 24 feet, depending on the location. However, these adjustments are expected long-term equilibrium conditions, which will take many years to stabilize (Anderson 2006). In this regard, NMFS expects that over time, the existing riparian vegetation will propagate itself, resulting in no significant loss of vegetation.

In addition, channel excavation will require the selective removal of some riparian vegetation. Currently, this vegetation provides shade during some hours of the day and seasons, is a source of allochthonous inputs, traps fine sediment, and provides bank stability. Although NMFS expects a short-term decrease in riparian vegetation from construction activities, we do not expect that allochthonous inputs, shading, or fine sediment trapping will decrease such that salmonid habitat will be measurably impacted. NMFS believes riparian vegetation removal is expected to result in insignificant effects to the listed salmonids and their critical habitats, and believes the return of a more functional estuary from an increase in tidal prism will benefit the listed salmonids and their critical habitats.

3. Sediment Mobilization

NMFS anticipates that short-term increases in turbidity will occur during proposed dewatering activities, construction and removal of cofferdams, instream construction activities, and channel adjustments. In addition, NMFS anticipates long-term increases in turbidity and sediment mobilization due to channel adjustments. Sediment may affect salmonids by a variety of mechanisms. High concentrations of suspended sediment can disrupt normal feeding behavior and efficiency (Cordone and Kelly 1961, Bjornn *et al.* 1977, Berg and Northcote 1985), reduce growth rates (Crouse *et al.* 1981), and increase plasma cortisol levels (Servizi and Martens 1992). High turbidity concentrations can reduce dissolved oxygen in the water column, result in reduced respiratory functions, reduce tolerance to diseases, and can also cause fish mortality (Sigler *et al.* 1984, Berg and Northcote 1985, Gregory and Northcote 1993, Velagic 1995, Waters 1995). Even small pulses of turbid water will cause salmonids to disperse from established territories (Waters 1995), which can displace fish into less suitable habitat and/or

increase competition and predation, decreasing chances of survival. Increased sediment deposition can fill pools and reduce the amount of cover available to fish, decreasing the survival of juveniles (Alexander and Hansen 1986).

Much of the research discussed in the previous paragraph focused on turbidity levels higher than those likely to result from the proposed construction activities. The applicant proposes to minimize the effects of these activities through de-watering procedures, use of cofferdams, use of existing staging areas, using access routes during dry conditions, use of mats and gravel on wet or soft soils on new access routes, re-vegetating new access routes upon completion, and mulching and seeding all disturbed dike and levee surfaces. Because of these proposed measures, turbid conditions during construction activities are expected to be minimal. In addition, sediment will be flushed through the Project area during the winter following construction activities, as well as each winter while channel adjustments occur. However, due to background turbid conditions associated with Salmon Creek, Hookton Slough, and Humboldt Bay, especially during high-flowing winter conditions, NMFS believes the increase in turbidity and sediment mobilization due to Project activities will result in insignificant effects to the listed salmonids or their designated critical habitats.

4. Habitat Improvements

Beneficial aspects of the Project will be realized immediately following construction in 2006. Passage conditions for adult and juvenile salmonids will be improved by excavating the knick point and replacing tide gates. Changes in the tidal prism are expected to return the Project area to a more functional estuary environment, and therefore, are expected to have long-term beneficial effects on salmonids and their habitat. Upon completion, juvenile and adult fish passage through the Project reach is expected to be enhanced and habitat quality and quantity increased.

VI. EFFECTS OF INTERRELATED AND INTERDEPENDENT ACTIONS

In considering the effects of the proposed action, NMFS analyzes the effects of any interrelated or interdependent actions that are likely to occur. No interrelated or interdependent actions have been identified for analysis in this Opinion.

VII. CUMULATIVE EFFECTS

NMFS must consider both the “effects of the action” and the cumulative effects of other activities in determining whether the action is likely to jeopardize the continued existence of the three salmonid species considered in this Opinion or result in the destruction or adverse modification of SONCC coho salmon, CC Chinook salmon, or NC steelhead designated critical habitat. Under the ESA, cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the action area. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require

separate consultation pursuant to section 7 of the ESA. NMFS is not aware of any State, tribal, local, or private actions that are reasonably certain to occur in the action area.

VIII. INTEGRATION AND SYNTHESIS OF THE EFFECTS ON SALMONIDS AND CRITICAL HABITAT

As discussed in the *Environment Baseline* section of this Opinion, SONCC coho salmon, NC steelhead, and CC Chinook salmon historically and presently inhabit Salmon Creek and Hookton Slough. Take of listed salmonids is expected to result only from de-watering and capture and relocation activities. NMFS anticipates a 1-6 percent mortality rate from de-watering and capture and relocation activities, assuming fish are present during construction activities. NMFS does not expect any other negative effects to listed salmonids from Project activities.

NMFS does not expect the reductions in juvenile abundance from capture and relocation activities to lead to a detectable change in returning adult abundance. Consequently, we do not expect the proposed action will appreciably reduce the Humboldt Bay steelhead, coho salmon, or Chinook salmon population's ability to survive and reproduce. Therefore, the proposed action will not appreciably diminish the likelihood of survival and recovery of the NC steelhead DPS and the SONCC coho salmon and CC Chinook salmon ESUs.

NMFS does not expect adverse effects to critical habitat from Project activities. The overall effects of the Project are expected to be beneficial to SONCC coho salmon, NC steelhead, and CC Chinook salmon, and their designated critical habitats. The Project will improve passage, and increase habitat complexity and diversity for adult and juvenile salmonids in the action area.

IX. CONCLUSIONS

After reviewing the current status of SONCC coho salmon, CC Chinook salmon, and NC steelhead, and their designated critical habitats, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that the proposed Project is not likely to jeopardize the continued existence of threatened SONCC coho salmon, NC steelhead, and CC Chinook salmon, and is not likely to adversely affect SONCC coho salmon, CC Chinook salmon, or NC steelhead critical habitat.

X. INCIDENTAL TAKE STATEMENT

Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct [ESA section 3(18)]. NMFS further defines harm to include significant habitat modification or degradation which actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (November 8, 1994, 64 FR 60727). Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise

lawful activity. Under the terms of sections 7(b)(4) and 7(o)(2) of the ESA, taking that is incidental to and not intended as part of the proposed action is not considered to be prohibited taking under the ESA, provided that such taking is in compliance with this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the USFWS and the Corps so that they become binding conditions of any grant or permit issued to the applicant in order for the exemption in section 7(o)(2) to apply. The USFWS and the Corps have a continuing duty to regulate the activity covered by this Incidental Take Statement. If the USFWS or the Corps (1) fails to assume and implement the terms and conditions of the Incidental Take Statement, or (2) fails to require the applicant to adhere to the terms and conditions of the Incidental Take Statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse [50 CFR § 402.14(i)(3)]. In order to monitor the impact of incidental take, the applicant shall report the progress of the action and its impact on the species to NMFS as specified in the Project biological assessment (Laird 2006).

A. Amount or Extent of Take Anticipated

NMFS cannot, with the current best available science, quantify anticipated incidental take of individual fish associated with implementation of the Project. NMFS expects take to occur to SONCC coho salmon, CC Chinook salmon, and NC steelhead in the form of “harass,” “kill,” or “capture” associated with dewatering and capture and relocation activities, resulting in injury or death to listed salmonids. The extent of mortality associated with dewatering and capture and relocation activities shall not exceed 6 percent of the number of fish relocated during the dewatering process.

Anticipated incidental take may be exceeded if the Project is not implemented as described in the Project BA or as described in this Opinion.

B. Effect of the Take

In the Opinion, NMFS determined that this level of anticipated take is not likely to jeopardize the continued existence of SONCC coho salmon, CC Chinook salmon, or NC steelhead.

C. Reasonable and Prudent Measures

Due to the extent of minimization measures proposed for the Project, including the fact that a qualified fish biologist will identify, record, and report to appropriate fisheries agencies all fish captured and relocated or the occurrence of any mortality, NMFS does not require a reasonable and prudent measure or associated terms and conditions from the USFWS or the Corps. NMFS believes that appropriate measures have been included in the proposed action to minimize take of SONCC coho salmon, CC Chinook salmon, and NC steelhead resulting from the implementation of the Project.

XI. REINITIATION OF CONSULTATION

This concludes formal consultation on the proposed Project. As provided in 50 CFR ' 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the extent of incidental take is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this Opinion, or (4) a new species is listed or critical habitat is designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, formal consultation shall be reinitiated immediately.

XII. REFERENCES

Section 7(a)(2) of the ESA requires biological opinions to be based on "the best scientific and commercial data available." This section identifies referenced data used in developing this biological opinion.

- Alexander, G. R., and E. A. Hansen. 1986. Sand bed load in a brook trout stream. North American Journal of Fisheries Management 6:9-23.
- Anderson, J. 2006. Correspondence regarding estimated changes to Salmon Creek habitat and channel morphology in response to increasing the tidal prism and removing a channel bed knick point. Jeff Anderson and Associates. Arcata, CA.
- Barnhart, R. A. 1986. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest)--steelhead. U.S. Fish and Wildlife Service Biological Report 82 (11.60). 21 pp.
- Barnhart, R. A. 1995. Salmon and steelhead populations of the Klamath-Trinity Basin, California. *In*: T. J. Hassler (*ed.*), Klamath Basin Fisheries Symposium, pages 73-97. California Cooperative Fishery Research Unit, Humboldt State University, Arcata, CA. Available from California Cooperative Fishery Research Unit, Humboldt State University, Arcata, CA 95521.
- Barnhart, R. A., M. J. Boyd, and J. E. Pequenat. 1992. The Ecology of Humboldt Bay California: an Estuarine Profile. U.S. Fish and Wildlife Service Biological Report 1. 121 pp.
- Behnke, R. J. 1992. Native trout of western North America. American Fisheries Society Monograph 6. American Fisheries Society, Bethesda, MD.

- Bell, M. C. 1991. Fisheries handbook of engineering requirements and biological criteria. Third edition. U.S. Army Corps of Engineers, Office of the Chief of Engineers, Fish Passage Development and Evaluation Program, North Pacific Division, Portland, OR.
- Berg, L., and T. G. Northcote. 1985. Changes in territorial, gill-flaring, and feeding behavior in juvenile coho salmon (*Oncorhynchus kisutch*) following short-term pulses of suspended sediment. Canadian Journal of Fisheries and Aquatic Sciences 42:1410-1417.
- Bisson, P. A., K. Sullivan, and J. L. Nielsen. 1988. Channel hydraulics, habitat use, and body form of juvenile coho salmon, steelhead and cutthroat trout in streams. Transactions of the American Fisheries Society 117:262-273.
- Bjornn, T. C. and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. *In*: W. R. Meehan (ed.), Influences of forest and rangeland management on salmonid fishes and their habitats, pages 83-138. American Fisheries Society Special Publication 19. Bethesda, MD. 751 pp.
- Bjornn, T. C., M. A. Brusven, M. P. Molnau, J. H. Milligan, R. A. Klamt, E. Chacho, and C. Schaye. 1977. Transport of granitic sediment in streams and its effect on insects and fish. University of Idaho, Forest, Wildlife, and Range Experiment Station, Bulletin 17, Moscow, ID.
- Boussu, M. F. 1954. Relationship Between Trout Populations and Cover on a Small Stream. Journal of Wildlife Management 18(2):229-239.
- Brown, R. F. and B. R. Mate. 1983. Abundance, movement and feeding habits of harbor seals, *Phoca vitulina*, at Netarts and Tillamook bays, Oregon. NOAA Fishery Bulletin 81(2):291-301.
- Brown, L. R, and P. B. Moyle. 1991. Status of coho salmon in California. Report to the National Marine Fisheries Service. 114 pp.
- Burgner, R. L., J. T. Light, L. Margolis, T. Okazaki, A. Tautz, and S. Ito. 1992. Distribution and origins of steelhead trout (*Oncorhynchus mykiss*) in offshore waters of the North Pacific Ocean. Int. North Pac. Fish Comm. Bull. 51. 92 pp.
- Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon and California. U.S. DOC, NOAA Technical Memo NMFS-NWFSC-27, Seattle, WA.
- California Advisory Committee on Salmon and Steelhead Trout. 1988. Restoring the balance. California Department of Fish and Game. 84 pp.

- California Department of Fish and Game. 1965. California Fish and Wildlife Plan, Vol. I: Summary, 110 pp.; Vol. II: Fish and Wildlife Plans, 216 pp.; Vol. III: Supporting Data, 180 pp. 1416 Ninth Street, Sacramento, CA 95814.
- California Department of Fish and Game. 1994. Petition to the California Board of Forestry to list coho salmon (*Oncorhynchus kisutch*) as a sensitive species. California Department of Fish and Game Report. 35 pp. plus appendices. (Available from California Board of Forestry, 1416 Ninth, Sacramento, CA 95814).
- California Department of Fish and Game. 1998. A report to the Fish and Game Commission: A status review of the spring-run (*Oncorhynchus tshawytscha*) in the Sacramento River drainage. Candidate Species Status Report 98-01. June.
- California Department of Fish and Game. 2002. Status Review of California Coho Salmon North of San Francisco. Report to the California Fish and Game Commission. April.
- California State Lands Commission. 1993. California's rivers, a public trust report. 304 pp.
- Campbell, E. A. and P. B. Moyle. 1990. Historical and recent populations sizes of spring-run chinook salmon in California. In: T. J. Hassler (*ed.*), 1990, Northeast Pacific chinook and coho salmon workshops and proceeding, pages 155-216. Humboldt State University, Arcata, CA.
- Chapman, D. W. and T. C. Bjornn. 1969. Distribution of salmon in streams, with special reference to food and feeding. In: T. G. Northcote (*ed.*), Symposium on salmon and trout in streams, pages 153-176. University of British Columbia, Vancouver, B.C.
- Cordone, A. J. and D. W. Kelly. 1961. The influences of inorganic sediment on the aquatic life of streams. Reprint from California Fish and Game. Vol. 47, No. 2. California Department of Fish and Game, Inland Fisheries Branch. Sacramento, CA. 41 pp.
- Cramer, F. K. and D. F. Hammack. 1952. Salmon research at Deer Creek, California. U.S. Fish and Wildlife Service, Spec. Sci. Report 67. 16 pp.
- Crouse, M. R., C. A. Callahan, K. W. Malueg, and S. E. Dominguez. 1981. Effects of fine sediments on growth of juvenile coho salmon in laboratory streams. Transactions of the American Fisheries Society 110:281-286
- Cushman, R. M. 1985. Review of ecological effects of rapidly varying flows downstream from hydroelectric facilities. North American Journal of Fisheries Management 5:330-339.
- Everest, F. H. 1973. Ecology and management of summer steelhead in the Rogue River. Oregon State Game Commission Fisheries Resources Report No. 7, Corvallis, OR. 48 pp.

- Everest, F. H. and D. W. Chapman. 1972. Habitat selection and spatial interaction by juvenile chinook salmon and steelhead trout in two Idaho streams. *Journal of the Fisheries Research Board of Canada* 29:91-100.
- Farro, M. 2005. Projects Manager. Personal Communication. Pacific Coast Fish, Wildlife and Wetlands Restoration Association. Arcata, CA.
- Fisher, F. W. 1994. Past and Present Status of Central Valley Chinook Salmon. *Conservation Biology* 8:870-873.
- Fisher, J. P., W. G. Pearcy, and A. W. Chung. 1984. Studies of juvenile salmonids off the Oregon and Washington coast, 1983. Oregon State University. Oceanography Cruise Report 84-2; Oregon State University Sea Grant College Program. ORESU-T-85-004:29 pp.
- Folmar, L. C. and W. W. Dickhoff. 1980. The parr-smolt transformation (smoltification) and seawater adaptation in salmonids: a review of selected literature. *Aquaculture* 21:1-37.
- Forest Ecosystem Management Assessment Team. 1993. Forest ecosystem management: an ecological, economic, and social assessment. U.S. Forest Service, National Marine Fisheries Service, Bureau of Land Management, U.S. Fish and Wildlife Service, National Park Service, U.S. Environmental Protection Agency. Portland, OR, and Washington D.C. 843 pp. plus appendices.
- Furniss, M. J., T. D. Roelofs, and C. S. Yee. 1991. Road construction and maintenance. Pp. 297-323 *In*: W.R. Meehan (1991).
- Giger, R. D. 1973. Streamflow requirements of salmonids. Oregon Wildl. Commission. Job Final Report, Project AFS-62-1, Portland, OR.
- Godfrey, H. 1965. Coho salmon in offshore waters. *In*: Salmon of the North Pacific Ocean. Part IX, Coho, Chinook, and Masu Salmon in Offshore Waters, pages 1-39. International North Pacific Fisheries Commission Bulletin 16.
- Good, T. P., R. S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-66. 597 pp.
- Graybill, M. R. 1981. Haul out patterns and diet of harbor seals, *Phoca vitulina*, in Coos County, Oregon. Master's Thesis. University of Oregon, Eugene, OR. 55 pp.
- Gregory, R. S. and T. G. Northcote. 1993. Surface, planktonic, and benthic foraging by juvenile chinook salmon (*Oncorhynchus tshawytscha*) in turbid laboratory conditions. *Canadian Journal of Fisheries and Aquatic Sciences* 50:233-240.

- Groot, C. L. and L. Margolis (editors). 1991. Pacific salmon life histories. University of British Columbia Press. Vancouver, B.C.
- Hankin, D.G. and M.C. Healey. 1986. Dependence of exploitation rates for maximum yield and stock collapse on age and sex structure of chinook salmon (*Oncorhynchus tshawytscha*) stocks. Canadian Journal of Fisheries and Aquatic Sciences 43:1746-1759.
- Hankin, D. G. and R. McKelvey. 1985. Comment on fecundity of chinook salmon and its relevance to life history theory. Canadian Journal of Fisheries and Aquatic Sciences 42:393-394.
- Hanson, L. C. 1993. The foraging ecology of harbor seals, *Phoca vitulina*, and California sea lions, *Zalophus californianus*, at the mouth of the Russian River, California. Master's Thesis. Sonoma State University, Rohnert Park, CA. 70 pp.
- Hapner, Nina. 2002. Personal communication. Table Bluff Reservation-Wiyot Tribe. Salmon Creek Advisory Meeting #1. February 13.
- Hartt, A. C. and M. B. Dell. 1986. Early oceanic migrations and growth of juvenile Pacific salmon and steelhead trout. International North Pacific Fisheries Commission Bulletin 46:1-105. In: Nickelson *et al.* (1992).
- Harvey, B. C. 1986. Effects of suction gold dredging on fish and invertebrates in two California streams. North American Journal of Fisheries Management 6:401-409.
- Hassler, T. J. 1987. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest)--coho salmon. U.S. Fish and Wildlife Service Biological Report 82 (11.70). 19 pp.
- Healey, M. C. 1986. Optimum size and age at maturity in Pacific salmon and effects of size-selective fisheries. Canadian Special Publication of Fisheries and Aquatic Sciences 89:39-52.
- Healey, M. C. 1991. The life history of chinook salmon (*Oncorhynchus tshawytscha*). In: Groot, C. L. and L. Margolis (editors), 1991, Pacific salmon life histories, pages 213-393. University of British Columbia Press. Vancouver, B.C.
- Healey, M. C. and W. R. Heard. 1984. Inter- and intra-population variation in the fecundity of chinook salmon (*Oncorhynchus tshawytscha*) and its relevance to life history theory. Can. J. Fish. Aquat. Sci. 41:476-483.
- Heifetz, J., M. L. Murphy, and K. V. Koski. 1986. Effects of logging on winter habitat of juvenile salmonids in Alaska streams. North American Journal of Fisheries Management 6:52-58.

- Higgins, P., S. Dobush, and D. Fuller. 1992. Factors in northern California threatening stocks with extinction. Unpublished manuscript, Humboldt Chapter American Fisheries Society. 24 pp. Available from Humboldt Chapter of the American Fisheries Society, P.O. Box 210, Arcata, CA 95521.
- Hinz, J. A. 1959. Annual report, Nimbus salmon and steelhead hatchery, fiscal year 1957-58. California Department of Fish and Game, Inland Fisheries Administrative Report No. 59-4.
- Hoar, W. S. 1976. Smolt transformation: evolution, behavior and physiology. *Journal of the Fisheries Research Board of Canada* 33:1233-1252.
- Hunter, J. W. 1973. A discussion of game fish in the State of Washington as related to water requirements. Report by the Washington State Department of Game, Fishery Management Division, to the Washington State Department of Ecology, Olympia, Washington.
- Jameson, R. J. and K. W. Kenyon. 1977. Prey of sea lions in the Rogue River. *Oregon Journal of Mammalogy* 58(4):672.
- Kalleberg, H. 1958. Observations in a stream tank of territoriality and competition in juvenile salmon and trout (*Salmo salar* L. and *Salmo trutta* L.). Rep. Institute Freshwater Research Drottingholm, 39:55-98.
- Kesner, W. D. and R. A. Barnhart. 1972. Characteristics of the fall-run steelhead trout (*Salmo gairdneri gairdneri*) of the Klamath River system with emphasis on the half-pounder. *California Fish and Game* 58(3):204-220.
- Kjelson, M. A., P. F. Raquel, and F. W. Fisher. 1982. Life history of fall-run juvenile Chinook salmon, *Oncorhynchus tshawytscha*, in the Sacramento-San Joaquin estuary, California. In: V.S. Kennedy (ed.), 1982, *Estuarine Comparisons*, pages 393-411. Academic Press, New York, NY.
- Kostow, K. 1995. Biennial Report on the Status of Wild Fish in Oregon. Oregon Department of Fish and Wildlife Report; 217 pp. + app. Available from Oregon Department of Fish and Wildlife, P.O. Box 59, Portland, OR 97207.
- Laird, A. 2006. Biological Assessment. Salmon Creek Anadromous Salmonid Access, Tide Water Habitat Enhancement, and Flood Control Maintenance Projects. Prepared for U.S. Fish and Wildlife Humboldt Bay National Wildlife Refuge Salmon Creek and Hookton Slough Units. March.
- Leidy, R. A. and G. R. Leidy. 1984. Life stage periodicities of anadromous salmonids in the Klamath River Basin, Northwest California. U.S. Fish and Wildlife Service, Division of Ecological Services, Sacramento, CA. 21 pp.

- Levy, D. A. and T. G. Northcote. 1982. Juvenile salmon residency in a marsh area of the Fraser River estuary. *Canadian Journal of Fisheries and Aquatic Sciences* 39:270-276.
- Lister, D. B., C. E. Walker, and M. A. Giles. 1971. Cowichan River chinook escapements and juvenile production 1965-1967. *Canadian Fisheries Service*. 1971-3. 8 pp.
- McLeod, D.A. 1991. Memorandum from David McLeod, California Department of Fish and Game, to Armand Gonzales, California Department of Fish and Game, regarding THP 1-91-132 Hum. May.
- Meehan, W. R. (ed.). 1991. Influences of forest and rangeland management on salmonid fishes and their habitats. *American Fisheries Society special publication* 19. Bethesda, MD. 751 pp.
- Meehan, W. R. and T. C. Bjornn. 1991. Salmonid distributions and life histories. *In*: W.R. Meehan (ed.), *Influences of forest and rangeland management on salmonid fishes and their habitats*, pages 47-82. *American Fisheries Society Special Publication* 19. Bethesda, MD. 751 pp.
- Miller, R. J. and E. L. Brannon. 1982. The origin and development of life-history patterns in Pacific Salmon. *In*: E.L. Brannon and E.O. Salo (eds.), *Proceedings of the Salmon and Trout Migratory Behavior Symposium*, pages 296-309. University of Washington Press. Seattle, WA.
- Mundie, J. H. 1969. Ecological implications of the diet of juvenile coho in streams. *In*: T. G. Northcote (ed.), *Symposium on salmon and trout in streams*, pages 135-152. H. R. MacMillan Lectures in Fisheries, University of British Columbia, Institute of Fisheries, Vancouver, B.C. 388 pp.
- Myers, J. M, R. G. Kope, G. J. Bryant, D. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. T. Lindley, and R. S. Waples. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-35. Northwest Fisheries Science Center, Seattle, WA. 443 pp.
- National Marine Fisheries Service. 1999. Biological Opinion and Incidental Take Statement—Effects of The Pacific Coast Salmon Plan on Oregon Coast Coho salmon, Southern Oregon/Northern California Coast Coho Salmon, and Central California Coast Coho Salmon. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Long Beach, CA. 29 pp.
- National Marine Fisheries Service. 2000. Biological Opinion and Incidental Take Statement – Effects of The Pacific Coast Salmon Plan on California Central Valley Spring-Run Chinook, and California Coastal Chinook Salmon. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Long Beach, CA. 29 pp.

- National Marine Fisheries Service. 2001. Status review update for coho salmon (*Oncorhynchus kisutch*) from the Central California Coast and the California Portion of the Southern Oregon/Northern California Coast Evolutionarily Significant Units. Southwest Fisheries Science Center, Santa Cruz Laboratory, CA. April 12. 43 pp.
- Nehlsen, W., J. E. Williams, and J. A. Lichatowich. 1991. Pacific salmon at the crossroads: Stocks at risk from California, Oregon, Idaho, and Washington. *Fisheries* 16(2):4-21.
- Nicholas, J. W. and D. G. Hankin. 1988. Chinook salmon populations in Oregon coastal river basins: Description of life histories and assessment of recent trends in run strengths. Oregon Department of Fish and Wildlife Fisheries Division Information Report No. 88-1. 359 pp.
- Nickelson, T. E., J. W. Nicholas, A. M. McGie, R. B. Lindsay, D. L. Bottom, R. J. Kaiser, and S. E. Jacobs. 1992. Status of anadromous salmonids in Oregon coastal basins. Unpublished manuscript. Oregon Department of Fish and Wildlife, Research and Development Section, Corvallis, and Ocean Salmon Management, Newport, OR. 83 pp.
- Nielsen, J., L. D. Tupper, and W. K. Thomas. 1994. Mitochondrial DNA polymorphism in unique runs of Chinook salmon (*Oncorhynchus tshawytscha*) from the Sacramento-San Joaquin river basin. *Conservation Biology* 8(3): 882-884.
- Norse, E. A. 1990. Ancient forests of the Pacific Northwest. Washington, DC: Island Press.
- Oregon Department of Fish and Wildlife. 1995. Letter to M. Schiewe regarding west coast chinook salmon status review by D. McIsaac. October 9. 9 pp.
- Pacific Coast Fish, Wildlife and Wetlands Restoration Association, Michael Love and Associates, Graham Mathews and Associates. 2003. Lower Salmon Creek Delta Salmonid Habitat Enhancement Opportunities, A feasibility Scoping Report for the California Department of Fish and Game and Humboldt Bay National Wildlife Refuge.
- Pacific Fishery Management Council. 2003. Pre-season Report I – Stock Abundance Analysis for 2003 Ocean Salmon Fisheries. Portland, OR. February.
- Redwood Community Action Agency and Humboldt Bay Watershed Advisory Committee. 2005. Humboldt Bay Watershed Salmon and Steelhead Conservation Plan.
- Reeves, G. H., F. H. Everest, and J. D. Hall. 1987. Interactions between the redbside shiner (*Richardsonius balteatus*) and the steelhead trout (*Salmo gairdneri*) in western Oregon: the influence of water temperature. *Canadian Journal of Fisheries and Aquatic Sciences* 44:1603-1613.
- Reiser, D. W. and T. C. Bjornn. 1979. Habitat requirements of anadromous salmonids. *In*: W. R. Meehan (*ed.*), 1979, Influence of forest and rangeland management on anadromous fish

- habitat in the Western United States and Canada, pages 1-54. Pacific Northwest Forest and Range Experiment Station. U.S. Department of Agriculture Forest Service General Technical Report PNW-96. U.S. Forest Service, Portland, OR.
- Rich, A. A. 1997. Testimony of Alice A. Rich, Ph.D., regarding water rights applications for the Delta Wetlands Project, proposed by Delta Wetlands Properties for Water Storage on Webb Tract, Bacon Island, Bouldin Island, and Holland Tract in Contra Costa and San Joaquin Counties. July. California Department of Fish and Game Exhibit DFG-7. Submitted to State Water Resources Control Board.
- Ricker, W. E. 1980. Causes of the decrease in age and size of chinook salmon (*Oncorhynchus tshawytscha*). Canadian Technical Report on Fisheries and Aquatic Sciences 944. 25 pp.
- Roffe, T. J. and B. R. Mate. 1984. Abundance and feeding behavior of pinnipeds in the Rogue River, Oregon. Journal of Wildlife Management 48(4):1262-1274.
- Sandercock, F. K. 1991. Life history of coho salmon. In: Groot, C. L. and L. Margolis (editors), 1991, Pacific salmon life histories, pages 397-445. University of British Columbia Press. Vancouver, B.C.
- Sanders, J. E., J. J. Long, C. K. Arakawa, J. L. Bartholomew, and J. S. Rohovec. 1992. Prevalence of *Renibacterium salmoninarum* among downstream-migrating salmonids in the Columbia River. Journal of Aquatic Animal Health 4:72-75.
- Saunders, R. L. 1965. Adjustment of buoyancy in young Atlantic salmon and brook trout by changes in swim bladder volume. Journal of the Fisheries Research Board of Canada 22:335-352.
- Scheffer, T. H. and C. C. Sperry. 1931. Food habits of the Pacific harbor seal, *Phoca vitulina richardsi*. Journal of Mammalogy 12(3):214-226.
- Schiewe, M. H. 1997a. Memorandum to W. Stelle and W. Hogarth. Conclusions regarding the Updated Status of Coho Salmon from Northern California and Oregon Coasts. National Marine Fisheries Service, Northwest Fisheries Science Center, 2725 Montlake Boulevard East, Seattle, WA 98112-2097. 70 pp. plus appendices.
- Schiewe, M. H. 1997b. Memorandum to W. Stelle and W. Hogarth. Status of deferred and candidate ESUs of West Coast steelhead. National Marine Fisheries Service, Northwest Fisheries Science Center, 2725 Montlake Boulevard East, Seattle, WA 98112-2097. 62 pp.
- Schluchter, M. D., and J. A. Lichatowich. 1977. Juvenile life histories of Rogue River spring chinook salmon *Oncorhynchus tshawytscha* (Walbaum), as determined by scale analysis. Oregon Department of Fish and Wildlife Information Report 77-5. 24 pp. Available from Oregon Department of Fish and Wildlife, 2501 SW First Street, P.O. Box 59, Portland, OR 97207.

- Servizi, J. A., and D. W. Martens. 1992. Sublethal responses of coho salmon (*Oncorhynchus kisutch*) to suspended sediments. *Canadian Journal of Fisheries and Aquatic Sciences* 49:1389-1395.
- Seymour, A. H. 1956. Effects of temperature on young chinook salmon. Ph.D. thesis. University of Washington, Seattle, WA.
- Shapiro and Associates, Inc. 1980. Humboldt Bay wetlands review and baylands analysis. Final report. U.S. Army Corps of Engineers, San Francisco, CA. 668 pp. and appendices.
- Shelton, J. M. 1955. The hatching of chinook salmon eggs under simulated natural conditions. *Prog. Fish-Cult.* 17:20-35.
- Sigler, J. W., T. C. Bjournn, and F. H. Everest. 1984. Effects of chronic turbidity on density and growth of steelhead and coho salmon. *Transactions of the American Fisheries Society* 113:142-150.
- Smith, A. K. 1973. Development and application of spawning velocity and depth criteria for Oregon salmonids. *Transactions of the American Fisheries Society* 102(2):312-316.
- Smith, L. S. 1982. Decreasing swimming performance as a necessary component of the smolt migration in salmon in the Columbia River. *Aquaculture* 28:153-161.
- Snyder, J. O. 1925. The half-pounder of Eel River, a steelhead trout. *California Fish and Game* 11(2):49-55.
- Snyder, J. O. 1931. Salmon of the Klamath River, California. *California Fish and Game Fisheries Bulletin* 34:130.
- Sparkman, M. D. 2002. Juvenile Steelhead Downstream Migration Study in the Mad River, Humboldt County, California – Spring 2001. Project 2a3. 2000-2001 Annual Report. California Department of Fish and Game. Steelhead Research and Monitoring Program. 52 pp.
- Sparkman, M. D. 2003. Upper Redwood Creek Juvenile Salmonid Downstream Migration Study, 2000-2002. Project 2a5. 2002 Annual Report. California Department of Fish and Game. Steelhead Research and Monitoring Program. 62 pp.
- Stone, L. 1897. Artificial propagation of salmon on the Pacific Coast of the United States with notes on the natural history of the quinnat salmon. *Bulletin of the U.S. Fisheries Commission for 1896*, 16:203-235.
- Thomas, V. G. 1985. Experimentally determined impacts of a small, suction gold dredge on a Montana stream. *North American Journal of Fisheries Management* 5:480-488.

- Thompson, K. 1972. Determining stream flows for fish life. *In*: Proceedings, instream flow requirements workshop, pages 31-50. Pacific Northwest River Basins Commission, Vancouver, WA.
- U.S. Army Corps of Engineers. 1977. Evaluations for improvement of Hookton Channel. San Francisco District.
- U.S. Department of Agriculture - Forest Service. 1995. Smith River Ecosystem Analysis: Basin and Subbasin Analyses and Late-Successional Reserve Assessment. Smith River National Recreation Area, Six Rivers National Forest.
- Van den Berghe, E. P. and M. R. Gross. 1984. Female size and nest depth in coho salmon (*Oncorhynchus kisutch*). Canadian Journal of Fisheries and Aquatic Sciences 41:204-206.
- Van Kirk, S. 1998. Land uses on Humboldt Bay tributaries. KRIS Coho Database.
- Velagic, E. 1995. Turbidity study: a literature review. Prepared for Delta planning branch, California Department of Water Resources by Centers for Water and Wildland Resources, University of California, Davis, CA.
- Velson, F. P. 1987. Temperature and incubation in Pacific salmon and rainbow trout, a compilation of data on median hatching time, mortality, and embryonic staging. Canadian Dept. of Fisheries and Aquatic Sciences. No. 626.
- Wallace, M. 2005. Personal Communication. Associate Fisheries Biologist. California Department of Fish and Game, Northern California- North Coast Region. Eureka, California.
- Walters, C. J., R. Hilborn, R. M. Peterman, and M. J. Stanley. 1978. Model for examining early ocean limitation of Pacific salmon production. Journal of the Fisheries Research Board of Canada 35:1303-1315.
- Waters, T. F. 1995. Sediment in Streams: Sources, Biological Effects, and Control. American Fisheries Society Monograph 7.
- Waples, R. S. 1991. Definition of "species" under the Endangered Species Act: Application to Pacific salmon. U.S. Department of Commerce. NOAA Technical Memorandum. NMFS, F/NWC-194. 29 pp.
- Weitkamp, L. A., T. C. Wainwright, G. J. Bryant, G. B. Milner, D. J. Teel, R. G. Kope, and R. S. Waples. 1995. Status review of coho salmon from Washington, Oregon, and California. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-24, Northwest Fisheries Science Center, Seattle, Washington. 258 pp.

Withler, I. L. 1966. Variability in life history characteristics of steelhead trout (*Salmo gairdneri*) along the Pacific coast of North America. Journal of the Fisheries Research Board of Canada 23:365-393.

A. Federal Register Notices

- 61 FR 41541. Endangered and Threatened Species; Proposed Endangered Status for Five ESUs of Steelhead and Proposed Threatened Status for Five ESUs of Steelhead in Washington, Oregon, Idaho, and California; Proposed Rule. August 9, 1996.
- 62 FR 24588. National Marine Fisheries Service. Endangered and Threatened Species; Threatened Status for Southern Oregon/Northern California Coast Evolutionarily Significant Unit (ESU) of Coho Salmon. May 6, 1997.
- 64 FR 24049. National Marine Fisheries Service. Designated Critical Habitat; Central California Coast and Southern Oregon/Northern California Coasts Coho Salmon. May 5, 1999.
- 64 FR 50394. National Marine Fisheries Service. Endangered and Threatened Species; Threatened Status for Two Chinook Salmon Evolutionarily Significant Units (ESUs) in California; Final Rule. September 16, 1999.
- 64 FR 60727. National Marine Fisheries Service. Endangered and Threatened Wildlife and Plants; Definition of “Harm.” November 8, 1999.
- 65 FR 36074. National Marine Fisheries Service. Endangered and Threatened Species; Threatened Status for One Steelhead Evolutionarily Significant Unit in California; Final Rule. June 7, 2000.
- 69 FR 71880. National Marine Fisheries Service. Endangered and Threatened Species; Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon (*Oncorhynchus tshawytscha*) and Steelhead (*O. mykiss*) in California; Proposed Rule. December 10, 2004.
- 70 FR 37160. National Marine Fisheries Service. Endangered and Threatened Species; Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs; Final Rule. June 28, 2005.
- 70 FR 52488. National Marine Fisheries Service. Endangered and Threatened Species; Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California; Final Rule. September 2, 2005.
- 71 FR 839. National Marine Fisheries Service. Endangered and Threatened Species; Final Listing Determinations for 10 Distinct Population Segments of West Coast Steelhead; Final Rule. January 5, 2006.